



THE
EDINBURGH SCHOOL
OF
MEDICINE;
CONTAINING THE
PRELIMINARY OR FUNDAMENTAL BRANCHES
OF
PROFESSIONAL EDUCATION,
VIZ.
ANATOMY, MEDICAL CHEMISTRY, AND
BOTANY.

Intended as an
INTRODUCTION TO THE CLINICAL GUIDE
THE WHOLE FORMING A COMPLETE SYSTEM OF MEDICAL
EDUCATION AND PRACTICE ACCORDING TO THE
ARRANGEMENT OF THE EDINBURGH SCHOOL.

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THE
ANATOMICAL GUIDE;
OR,
A VIEW
OF THE
ANATOMY AND PHYSIOLOGY
OF THE
HUMAN BODY,
IN THE
SOUND AND MORBID STATE;
WITH THE
APPLICATION OF CHEMISTRY,
AND THE CHIEF MODES OF ANATOMICAL PREPARATION
WHICH HAVE BEEN EMPLOYED IN ORDER TO
FACILITATE THE EXPLANATIONS OF
ITS STRUCTURE.

TO
DR. MATTHEW BAILLIE,

FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS
OF LONDON, F. R. S. &c. &c.

*THE Anatomical Part of this Work is In-
scribed, as a Mark of Professional Respect,
and as a proper Return for the many valuable
Observations it contains, derived from his
Writings ; by*

THE AUTHOR.

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DEMONSTRATION
AN
DISSECTIO



I.

FROM the chylopoëtic viscera, our attention is next directed to those organs which are termed their assistants. The principal of them is the liver.

II.

LIVER.

This organ is the largest gland in the body. It is of a dusky red colour, situated immediately under the diaphragm, in the right hypochondrium, and its bounds are touched by the edge of the thorax, expanding to the region of the stomach, and even to the left hypochondrium. On its upper surface it is convex and smooth, where opposed to the diaphragm, only flattened on its left side, where its surface meets the situation.

of the heart. On its under side its surface is irregular, though at the same time concave, and here it is opposed to the stomach and intestines.

III.

Towards the ribs it is thick, and gradually becomes thinner as it advances forwards towards the left side. On its posterior edge it is blunt or obtuse. On its anterior it is sharp or acute, and from side to side its breadth exceeds what it does from before backwards.

IV.

Lobes.

In entering into a particular description of the liver, the first parts of it to be demonstrated are its lobes, and these are divided into its great and small ones, which are so considerable, as to form its body and whole upper part. In point of situation, the great lobe is placed obliquely in the right hypochondrium, and follows the curve of the diaphragm; while the small one, divided by a broad ligament, is situated almost horizontally.

V.

Besides these lobes, some smaller ones also fall to be noticed, as, 1. The lobe of Spigelius, situated on the left side of the great lobe, near the spine, and projecting like a nipple at the small curvature of the stomach: 2. The lobulus caudatus, angle of the former, situated at the middle

- of the lower side of the great lobe : and, 3. The lobulus anonymus, broader, though less prominent than the former lobule, and placed between the passage of the round ligament and the gall bladder.

VI.

Ligaments.

The next parts of this organ are its ligaments, or connecting processes, which are chiefly formed from the doubling of the peritonæum.

1. The first is the suspensory one, or broad ligament, placed above between the great and small lobes, and extending below into the umbilical fissure. It is connected obliquely to the diaphragm, and tip of the ensiform cartilage, and descending in the same direction, it adheres to the lower part of the sheath of the rectus abdominis muscle on the right side.

2. The round ligament, which is the remains of the umbilical vein, placed in a doubling at the under part of the former one, and fixed to the navel.

3. The right lateral ligament, which connects the thick great lobe at its back part with the posterior part of the diaphragm.

4. The left lateral ligament, longer than the former one, and which serves for the connection of the left extremity of the small lobe to the diaphragm.

5. To these is commonly added the external coat of the liver, which is merely cellular substance, and unites the root of the liver to the tendinous part of the diaphragm.

VII.

Thus, by the first of these ligaments is the liver preserved in the erect posture. By the second it is prevented, in lying down, from pressing on the diaphragm, so that they both suspend it, and prevent its pressure on the ascending cava.

VIII.

Fissures.

Next, after the lobes and ligaments of this organ, fall to be demonstrated its fissures or depressions, which are chiefly on its under side.

The first is the umbilical fissure between the great and small lobes, and at the under and fore part of the liver. This fissure is of different depth in different bodies, and behind it is commonly covered with the bridge or isthmus of the liver.

2. The second is the transverse fissure, or sinus portarum, extending from right to left between the great and small lobes, by which its extremities are bounded; and having the lobulus anonymus before, and that of Spigelius behind, the connection of these last forms an appearance

compared to a gate, and therefore distinguished by the name of porta.

3. The intermediate dépression for the passage of the vena cava, between the great lobe and that of Spigelius, which has frequently a bridge over it, forming it into a canal.

4. The depression of the ductus venosus running a little obliquely from the right to the left side, and receiving a ligament, part of the umbilical vessels.

IX.

From the peritonæum, this organ derives a coat which adheres closely to it, and every where it is covered by this membrane, except behind, where cellular substance connects it to the diaphragm.

X.

This organ is chiefly composed of a variety of vessels, the extreme branches of which are intermixed in such a manner, as to form numberless pulpy corpuscles, termed acini, from their resemblance to stones or small kernels of fruit; and these again subjected to examination, appear composed of vessels in the form of radiated villi.

XI.

From the importance of the liver, its circulation ought to be well understood. It is in this vascular congenies that disease is more apt to form than elsewhere, and it is here the blood

even loses more of that principle on which its peculiar stimulus depends.

XII.

The principal artery of the liver is the hepatic, which is sent off from the celiac at the point of the Spigelian lobe. Its root is covered by the pancreas, and it passes under the stomach and duodenum, under the omentum and biliary ducts till it arrives at the porta; and having divided a little before into two branches, these enter the great and small lobes of the liver. Being inclosed in the passage into the liver, on the cellular membrane, termed the glisson's capsule.

XIII.

Before its separation, this artery in its progress gives off branches to different organs as it passes them. The first are small twigs to the *venæ portæ*, and to the head of the pancreas, to the large branch termed the *arteria duodeno gastrica*, which again soon after its origin separates into two principal divisions, one of which supplies the stomach and omentum, named the *gastro epiploic artery*; the other pervades the duodenum, and gives circulation to the pancreas, termed *arteria pancreatico duodenalis*. Besides these larger branches, smaller arteries also arise, one advances to the upper and back part of the duodenum, over the biliary ducts. Next go off small arteries

to the duodenum, and also to the pancreas. Of these deserving notice, is the lower pyloric artery, or branch of the *pancreatico duodenalis*, sent off as it reaches the duodenum. Others arise at the same time, which encircle the pylorus, and chuse a direction upwards, in order to inosculate with twigs from the upper pyloric, which comes from the artery of the stomach.

The next artery, from the same origin, is a neat small branch, named the transverse pancreatic artery, passing under this organ, and running along its back part. It sends branches into the substance of the viscus from side to side, and is exhausted after pervading $\frac{2}{3}$ of the gland. In its farther course along the circle of the duodenum, the *arteria pancreatico duodenalis* gives off arteries outwards to the duodenum, and inwards to the pancreas, till it ends by an inosculation with the mesenteric artery.

XIV.

When the *pancreatico duodenalis* passes down, the other great division formerly noticed, passes up to the stomach and omentum, named therefore the *gastro epiploic* artery. The course of this artery is along the lower part of the stomach, making a broad sweep round its great arch. Branches are distributed by it in every direction along the organ, and also to the omentum. In its progress along the stomach it inosculates with

the splenic artery, and the place of this, from inspection, is uncertain; and, while the splenic artery forms the right artery of the stomach, this one is properly the left one. Another branch still remains to be noticed, given off by the hepatic artery, before entering the liver. This is the

XV.

Pylorica Superior Hepatica,

Which comes off before the hepatic divides, or immediately after, from its left division. It returns in a backward direction to the upper arch of the stomach, and expanding some small twigs on the lesser omentum, it passes directly over the pylorus, with whose upper and lower arteries it forms anastomosis.

XVI.

Hepatica Sinistra.

Within two inches of the liver, the hepatic artery is divided into two principal branches, which enter at the porta of the liver, but pass the one to the right, the other to the left lobe of the organ. This branch to the left is smaller than the other. It climbs upon the vena portæ, and enters the liver at the fossa umbilicalis. Its circulation within the liver is chiefly distributed to the left lobe, the lobe of Spigelius, and the anonymous lobe.

XVII.

Hepatica Dextra.

The right hepatic branch passes under the biliary ducts. With them it enters the right lobe of the liver, previous to which it gives off the arteria cystica, or branch that supplies the circulation of the gall bladder. Before considering the venous system of the liver, it is proper to examine its appendage, or the gall bladder.

XVIII.

Gall Bladder.

It is a small oblique pyriform bag, found on the under surface of the liver, half sunk into the substance of the liver, and nearly horizontal when this organ is fixed in its place. It is connected by the ductum communis coloni, so as to receive its secretion to these parts, and it opens a little to the right side.

XIX.

This gland possesses four different coverings, or coats, in the same manner as the other bowels. The first, or external one, is derived from the peritoneum, and is the same that is expanded over the liver. The second is its muscular coat, which consists rather of a few scattered fibres than any regular muscular structure. The third is a condensed cellular texture, which is named its nervous coat; and the fourth, or its inner

surface, from its small reticular rugæ, or folds, is termed its villous coat. This rugated structure is more minute towards its neck than elsewhere, and its folds appear to run in a longitudinal direction. This internal covering is every where perforated by small ducts, the excretories of small follicles, through which a mucus is discharged to defend the surface from the irritation of the biliary secretion.

XX.

Through its whole length, the gall bladder is connected by a cellular intermedium to the liver, as well as by its vessels. Its principal vessel, the cystic artery, already noticed, branches over it betwixt its coats in the form of a coronary artery, and being ramified in a beautiful manner, passes from it to the liver.

XXI.

The veins of the liver arise from two sources, the vena portæ, and the terminations of its own arteries. The former is so named from its situation with respect to the porta of the liver. It consists of the veins gathered together from the intestinal canal, and from the spleen, and pancreas, and its trunk lies obliquely across the spine. On entering the liver, it distributes branches through the substance of the organ, and thus, from being derived from two origins, the hepatic veins are exceedingly numerous. The veins from both

origins unite by degrees, and accompany the other vessels; but, at the root of the liver, they form two or three large trunks, which terminate at the vena cava on its perforation of the diaphragm. Thus the vena porta is a peculiar part in addition to the internal circulation of the liver, being a vein performing the office of an artery, by distributing the blood it collects from the arteries of the intestines, which blood is intended particularly for the secretion of the bile. From the extremities of the porta, therefore, the biliary ducts arise by extremely minute branches, termed *pori biliarii*, or *tubuli biliferi*, expanded over the substance of its pulpy corpuscles. These ducts gradually unite in their progress into larger branches, which collect at last into two, and run in the end into one, named the *ductus hepaticus* situated in the *sinus portarum*.

XXII.

By the *ductus hepaticus*, the gall, or bile, of a yellow green colour, is conveyed from the liver; and by the appendage of the liver, the gall bladder, or receptacle of the bile, a duct is also sent out, termed the *cystic*. The union of these ducts is termed the common one or *choledochus*, and through it the bile is received from the hepatic duct to be conveyed in part into the cystic one, and thus lodged in the gall bladder.

XXIII.

From considering the general structure and circulation of the liver, we are led to examine its peculiar office of preparing and separating the bile for the use of digestion; for, whilst the bile promotes the dissolution and assimilation of the food, it irritates at the same time the coats of the alimentary canal, and hence, when the flow of it into the gut is any how obstructed, the person becomes costive.

XXIV.

It appears from a variety of circumstances, that the secretion of the bile is chiefly made from the vena portarum. At first sight this might be supposed from comparing the great size of the ducts with the arteries, or from having observed a very singular connection of veins; the only purpose of this, that can be reasonably supposed, is, that a certain change of the blood, and a certain momentum, different from what is seen in other parts of the body, is necessary for the parts of the bile; for what other use can be assigned for this singular course of the blood? But, besides mere probability, it is fully confirmed by making injections; and by those made from the vena portarum, the secretion of the bile may be imitated, and pushed into the biliary ducts; while, from the biliary ducts, though

it passes backwards with much more difficulty than forwards, yet it can be made to return.

XXV.

At the same time, there is reason to suspect that a portion of the bile is derived from the hepatic artery; for, when this artery is followed to the liver, we find a branch sent to the gall bladder, called the cystic artery, and it returns into the vena portarum, not into the vena cava, but all these branches spent upon the liver terminate in the vena cava. Since the conclusion to be drawn is, that the blood returns from the gall bladder into the vena portarum, because no secretion of bile has been made directly from its branches into the gall bladder, it is not deprived of that somewhat fit for the formation: but the other branches having furnished this somewhat, return to the heart directly. And to confirm this, on making the same experiment upon the hepatic artery as upon the vena portarum, there is a similar communication, though it is less evident; for, upon injecting the artery, the injection gets into the ducts, it is possible that the liquor may have penetrated into the vena portarum, or the beginning of the vena cava hepatica common to both: but still there is a passage.

XXVI.

Thus the vena portarum chiefly makes the secretion of the bile, and the hepatic artery assists while, perhaps, it performs other offices, by no means understood. Anatomists and physiologists are apt to get into a train of accounting for things without reflection. The hepatic artery has been said as serving to nourish the liver. Now, how does it appear that the vena portarum cannot nourish it? All those that admit of the nourishment being conveyed by arteries, admit that the cæliac and both mesenteric arteries can nourish the stomach, pancreas, guts, and spleen, how is the blood so deprived of nourishing matter that it cannot furnish enough to the liver? It is taken for granted, rather than proved, and we have by no means an absolute proof that it does serve this purpose; only from comparing the heart, lungs, &c. we find that blood, by having undergone one circulation, is deprived of somewhat material to us. Thus however great the quantity, that the whole mass in the lungs is not sufficient to perform certain purposes, unless somewhat is added by the bronchial artery, so that the hepatic artery may serve similar purposes to the liver, and one of these may be nutrition: but we do not prove this with certainty, far less that it is the only purpose.

XXVII.

From the secretion within the liver, it falls next to be determined whence the bile in the gall bladder is furnished. It is commonly taught, that the gall bladder receives its bile from the liver through the hepatic, and afterwards through the cystic duct, *i. e.* it descends by the hepatic duct, meets with more resistance in passing into the duodenum, in the empty state of the gall bladder, than to its regurgitation into the bladder. So, where there is any considerable resistance by aliment or wind within the duodenum, and the gall bladder is not fully distended, the bile passes upwards, to be lodged there for a certain time, and after remaining there it is pushed down, either by the pressure of the stomach, or action of the external parts of the diaphragm and abdominal muscles, or by a supposed action of its own coats, through the cystic and through the common duct into the cavity of the intestines; or that the cystic and hepatic bile have the same origin, and only differ in consistence, for by the stagnation, changes are made, the thinner parts are taken away by the absorbent vessels; but there may be, besides, other changes made in consequence of the stagnation, intestine changes which we cannot so clearly point out.

XXVIII.

Another opinion supposes, that either the coats of the gall bladder furnished the cystic bile, or that the gall bladder receives it by particular small ducts opening directly into it. This opinion was suggested by Dr. Albinus, that the cystic bile was derived from the coats of the bladder; and he has mentioned several circumstances that seem, at first sight, to prove it. Thus, upon the inner part of the gall bladder, when slit open, we find minute follicles, which are supposed to contain the bile, and that in them it acquires its toughness and greater viscosity, just as in the throat and alimentary canal, the mucus is inspissated. A very great difference is also observed in many animals, in their consistence and properties, as in birds, where the bile of the liver has a sweet taste, while that in the bladder is intensely bitter, so that there seems some very essential difference; and it is farther found, that the cystic and hepatic ducts run parallel to each other, and open separately into the cavity of the intestines, which is likewise a fact, without any communication in their course downwards. Besides this, cases are described where the cystic duct was found obstructed by calculi, and yet a considerable quantity of bile was found distending the gall bladder.

XXIX.

Now to shew that, with all these appearances of probability, this notion is destitute of foundation, it may be observed that these follicles are indeed in the gall bladder, but they are also every where in the other ducts, and they are particularly numerous in the ductus communis; and when we examine the contents, we find a clear mucous matter within the follicles. So that they are merely intended for a defence against an acrid matter, just as the bladder is covered with a quantity of slime, which, in some diseases, is discharged in great abundance. With regard to the two, they agree in colour; and, by inspissating the hepatic bile, we imitate the cystic. So that all the changes may be accounted for from the effect of stagnation and absorption.

XXX.

With regard to birds, upon blowing into the hepatic duct upwards towards the liver, we inflate the gall bladder, there are large branches sent off to the gall bladder, there are hepatocystic ducts from the branches of the hepatic ducts. And where the gall bladder has been distended with bile, and yet a stone found, the stone has been moveable, and the bile passed the sides of the stone; and the stone being pressed down into the duct, acted as a valve, just as a cork within a bottle stops the liquor before it is

poured out of it : and a vast number of cases can be pointed out, where the cystic duct being totally obstructed, by a stone immediately put into it, the gall bladder was found empty, the sides almost contiguous and quite flaccid ; and a single instance of this kind is decisive, because, were the opinion just in consequence of the impaction, the bladder should necessarily be found distended with bile ; and, upon tying the cystic duct after 20 or 30 hours, it has been found more empty than at the time of the experiment.

XXXI.

The same arguments refute another supposition, the applying to men the analogy of birds or the having the hepato-cystic-duets, whilst it is admitted that some portion of the bile may come through the cystic duct, it is alleged that a principal supply is from the liver directly into it ; and some have pretended to describe these ducts, and probably from what seemed a real observation, for considerable branches of the hepatic duct run about the gall bladder, which are more superficial in that place than in any other, the gall bladder serving as a defence to the ducts. But wherever we find such ducts, there is no communication between the trunks ; the hepato-cystic ducts serve the purpose of this joining ; and where these are found, there may be some further communication.

XXXII.

But to refute such opinions by direct facts, the hepatic duct may be injected without a drop entering the gall bladder; and the gall bladder may be opened, cleaned in its inner coat, and the liver then squeezed without finding a drop poured out; and when the cystic duct is completely stopped or tied, the gall bladder remains empty. So we may consider it as a point established in physiology, that the bile descends from the liver by the hepatic duct, and passes by the cystic into the gall bladder, and returns again through the same channel. And there is no improbability in the flow being different at different times.

XXXIII.

Chemical Analysis of the Liver.

The secretion of the liver, or the bile, is one of the most important in the animal system, and it is of two kinds, the hepatic and cystic, or that forced directly from the organ into the duodenum, and that which passes into the gall bladder, and is there allowed to accumulate.

1. The hepatic bile is thin, of a faint yellow colour, inodorous, and but slightly bitter, as is perceptible on eating the liver of animals.
2. The cystic bile is thick, of a deeper colour, more acrid, and bitter to the taste.
3. The proper colour of the bile is a yellowish green, of a soapy or oily consistence, resembling in its frothy-

ness, on agitation, a solution of soap and water. In its taste it is less bitter than that of animals.

4. The principles of the bile detected by chemistry, consist of,

- a. Water, in a great proportion.
- b. Albumen, as precipitated by alcohol and mineral acids.
- c. Resin, as detected by the solution of bile, and its evaporation.
- d. A colouring principle contained in the resin.
- e. Soda, in a caustic state, forming neutral salts, with acids.
- f. Phosphorated calx, with a small portion of iron and culinary salt.

5. The bile has been considered as an animal soap, yet it differs from it in some leading particulars, for it neither dissolves oil, nor mixes with water like soap.

6. Bile is very subject to putrefaction, unless reduced to the state of an extract.

7. This secretion has been considered as the blood deprived of its oxygen, and it is confirmed by an experiment of coagulating two parts of blood with one of distilled water by fire, when the filtered liquor resembles bile; and the same effect follows the boiling of blood with fuming spirit of nitre, instead of water.

8. The primary use of the bile seems, 1. The extrication of chyle from the chyme, as sent into the duodenum. 2. The exciting the peristaltic motion of the intestines. 3. Imparting the yellow colour to the faeces; and 4. Preventing accumulation of mucus, and disengaged acid in the primæ viæ.

Anatomical Preparation of the Liver.

A corroded preparation of the liver is the best mode of shewing its structure; and, in order to do it completely, it requires four pipes, and as many different coloured injections. The vessels by which this organ are injected, are the hepatic artery coming off from the cæliac, the vena portarum, the vena cava ascendens, and the hepatic duct, through which the bile is conveyed. The vena cava on the superior surface of the liver, should be secured by a ligature after the blood is washed out as clean as possible. The injection is then to be made in the usual manner, and when finished, the pipes are to be removed, and the liver put into the acid liquor for corrosion before the injection becomes cold and brittle, and it should never be handled till it is perfectly corroded, Then let it be washed clean, and when dry, varnished.

XXXIV.

Spleen.

After the liver, the next organ that falls to be examined is the spleen; which is a soft vascular body, of a purple colour. In its shape it is long and oval, of a considerable size, and occupying a space immediately under the diaphragm, or the left side of the stomach near the ribs, and above the left kidney.

XXXV.

The situation of the spleen, however, is subject to some variety from two circumstances, the state of respiration, and the dilatation or empti-

ness of the stomach; for it rises or falls with the dilatation of the lungs, and its obliquity is greater or less according to the distension of the stomach.

XXXVI.

The external surface of this organ is convex and uniform, corresponding to the surface of the ribs, to which it is opposed; while internally towards the spine, it is irregularly concave. In size, the spleen is about 5 or 6 inches long, 3 broad, and 1 thick. Its anterior part is more concave than the posterior one, and answers to the convexity of the stomach. Deep fissures are observable in different parts of its edges, and it is not uncommon to have a smaller spleen connected with the large one.

XXXVII.

The connections of the spleen are numerous. Below, it is fixed to the omentum, and the omentum and blood vessels join it again to the stomach. Behind, it is connected above to the diaphragm; and below, through the intervention of the peritonæum and intermediate cellular membrane to the left kidney and colon.

XXXVIII.

The substance of this organ is uncommonly soft, and by far the most tender of the abdominal bowels. It possesses two layers or coverings, one the peritonæal coat, the other proper to itself, but

closely joined to the former covering. When the substance of the organ is examined, it seems a congeries of vascular parts united by cellular matter, and the extremities of its vessels terminate in penicelli or small brushes, somewhat similar in appearance to glands. So delicate is the structure of its vessels, that any injection of it made, is found to extravasate into its cellular membrane, and to give its structure a follicular appearance.

XXXIX.

In proportion to its size, the vessels of the spleen are larger than those of any other organ. Its artery is a principal branch of the cæliac, and is one of the most remarkable in the body. It is as large as a goose quill. It proceeds from the cæliac trunk at right angles, and runs a foot in length across to reach the spleen. In this course it observes a serpentine direction; and, after sending off branches to the pancreas, and the arteriæ breves to the left end of the stomach, it goes into the substance of the spleen, dividing into a great many branches which enter by the concave surface of the organ, and plunge deep into its substance.

XL.

The first of the branches of the splenic artery thus described, is the pancreatica magna, which passes to the right, under the pancreas, and belongs chiefly to its rounded end, under the duodenum.

2. By the border of the pancreas to the left it sends also short branches into that organ.

3. Next, its branches ascend to the back part of the stomach, and its very large and principal one, is the gastroepiploic artery. It arises under the stomach, beyond the head of the pancreas, makes a serpentine arch, turning upon the stomach, and sending branches up to it, and down upon the omentum.

4. Last of all, the vasa brevia are given off to the stomach before it enters the spleen.

XLI.

The splenic artery then entering the spleen, is subdivided into branches, which are crowded together, and run in every direction, forming at length plexus or penicelli, which terminate in the branches of the corresponding vein. This vein is larger in proportion than the artery. It is much ramified, and carried through the whole of the organ. It receives the blood without the intervention of cells, and into it flow the contents of the vena brevis, of the stomach, veins of the pancreas, &c. so that it forms a chief branch of the vena portæ.

XLII.

From the spleen, no excretory duct has been found to proceed, which has rendered the use of this organ ambiguous. It appears, however, from

the termination of its vessels on the vena portæ, that it has a connection with the secretion of the liver, and that it disposes the blood collected in the vena portæ, to be more easily formed into that secretion. ‘

XLIII.

The spleen thus appears like a clot of blood inclosed in a membrane of no greater thickness or toughness. We find arteries in great number conveying a great proportion of blood into the substance of it, and there divided into very minute branches. In like manner, there are a number of very minute branches of veins, joining together to form larger veins, and forming a trunk, terminating in the vena portarum. In the human body there is no intervention of cells, which are only seen when an injection is thrown in with too great force, in which case there is an extravasation into the cellular membrane. Neither do we observe knots that may be called glandulæ, or any ducts or hollow tubes sent out, except the red veins and common lymphatic vessels. ‘

XLIV. ‘

What account, therefore, is to be given of the spleen? This may be judged of from the want of particular ducts, that we can only form con-

jectures about it; and the variety of opinions advanced, plainly prove the uncertainty of all of them; and indeed most of them are such as scarcely merit attention.

XLV.

A late opinion concerning the spleen forming the red part of the blood, cannot even be excepted; so that there is nothing fixed or determined concerning the use of the spleen, further than a general presumption that it is subservient to the liver. For let us see what kind of notion we can have of the spleen forming the red part of the blood. We observe a very great quantity of red blood entering the spleen: Surely that can be no argument for its forming the blood? It is formed before it enters; and the only foundation for the opinion is, that red particles are observable in the lymphatic vessels, when these are tied up. But the spleen has been cut from animals, they have survived the operation, days, months, and years, and the colour of the blood has remained all the while the same. How is this to be explained? That the lymphatic vessels of the spleen chiefly convey the red parts, but that the whole lymphatic system contributes in the same office. So far such an hypothesis may be commended as serving for a retreat, but what are

we to think of it? That the vessels by nature intended for absorbing the colourless part of the blood, which in a sound animal convey only the colourless parts, are to be supposed to form the red globules. There is certainly an improbability in it, to suppose that lymphatics that take in a fluid from the surface of the skin, shall change its nature, and convert it into red. Why lay the burden upon that part of the system called lymphatic? Why have recourse to more than the first beginnings of the lacteals, and to suppose that the food may be so converted? But, to shew the absurdity of such opinions, we find that the experiment succeeds in the same way in whatever organ of the body it is made. We know from a great number of experiments, that wherever we let in air upon the sensible and deep seated organs, whether we tie up the lymphatic vessels or not, we shall find red parts conveyed through every lymphatic vessel, because from the irritation of the air such an inflammation is produced as gives occasion to the effusion of the red parts, which are again taken up by the absorbent system.

XLVI.

But, further, if the spleen was intended for the formation of the red blood, why is the blood

fent from it into the liver? Why, after performing its office, does it not return in its shortest road into the vena cava.

XLVII.

We may say that the bile is thrown in to the force of the blood, as it is in the second circulation that the bile is best formed. But in the herbivorous animals, where the tract is longer, and more blood dispersed upon the alimentary canal, we still find a spleen: so that it would appear that some change, which we perhaps shall never be able to ascertain accurately, is produced on the blood in its passage through the spleen, such as fits it for the separation of the bile. (There is the strongest reason to believe that it is subservient to the liver, though with regard to the manner, we shall perhaps never be able fully to understand it. From experiments that have been made by cutting out the spleen, and observing the changes made upon the bile, we can yet conclude nothing certain, and we can draw the most general conclusions only, that it is constant in all animals in which bile is secreted; and in all, the blood enters from it into the vena portarum, which is the principal organ serving for the separation of the bile.

XLVIII.

Anatomical Preparation of the Spleen.

As the texture of this organ is so soon broken down, it must be procured for injection in the most recent state. It is to be injected only by the artery and vein, since it possesses no excretory duct; and, if the organ is fresh, the extremities of the veins will appear uniformly coloured. The after-treatment is to be conducted in the same manner as described in the liver.

XLIX.

Pancreas.

The pancreas is a long flat gland of the conglomerate kind. It is situated in the epigastric region, and placed transversely on the back part of the abdomen, between the stomach and spine. In shape it is said to resemble much the tongue of a dog, and it possesses an elongation or process from one of its extremities, which adheres closely to the duodenum, and is termed its head.

L.

In describing more particularly its situation, the body of the pancreas passes before the upper part of the transverse portion of the duodenum, and over the aorta, vena cava, and part of the splenic vessels, to all of which it is attached; and through the intervention of the omentum, one end of it also is fixed to the spleen. Its membranes are derived from the mesocolon, and consist of two layers.

LL.

The structure of the pancreas consists of acini, which unite to form small glands or lobes. A quantity of cellular substance loosely connects them, so that an external appearance of smoothness and uniformity is afforded. The circulation of the pancreas has been already detailed in that of the preceding organs, its arteries arising from the hepatic and splenic by several branches which pass into its substance in different places, and chiefly in a transverse direction. Its veins observe the same name and course as its arteries, and terminate in the vena portæ.

LII.

From the different acini of this organ, small ducts arise which unite and form larger ones, and in their course they observe a transverse direction. They at last meet in one common duct, termed the pancreatic duct.

LIII.

The pancreatic duct begins at the left extremity of the pancreas, and runs in the substance of the gland, a little below its middle, gradually enlarging in size in its course in consequence of the different branches joining it, till at last it is found equal to a small quill. At the right extremity of the organ it receives the duct of the elongation or process, and it then terminates ob-

liquely in the duodenum, along with the ductus communis choledochus, though the place of this termination varies a little at times.

LIV.

The use of the pancreas is clearly to secrete a fluid of a salivary nature, which is poured into the intestines.

LV.

To sum up our opinion of this organ, we observe, that it is the principal salivary gland. There is a sameness of colour, a similar division into lobes, the coats of the ducts thin and transparent, very much resemble the coats of the inferior maxillary gland, and sometimes concretions form within the ducts, resembling some of the other salivary concretions, and they agree perfectly in colour and consistence. One farther resemblance may be pointed out, that mercury affects these glands in like manner as the salivary glands are affected; and it is suspected that the diarrhoea which mercury produces, is very much owing to an increased discharge from the pancreas; and, when a pipe is fixed into the duct of the pancreas, a liquor like the saliva is discharged from it.

LVI.

The arteries of the pancreas come from the splenic arteries, nearly at right angles, and it happens that all the salivary glands are supplied

with arteries much in the same manner: so that the direction no ways corresponds to the effect of mercury upon them, which was supposed to be thrown into the arch of the aorta towards the head, and to be determined into these glands by the direction of the arteries, and the pancreas was overlooked. But it is evident that the effect of mercury here is to be explained upon the very same principles as the secretion of the saliva. Why do these glands separate spittle? Whoever shall explain this, will be better able to explain the other. They both depend upon a particular organization, upon minute circumstances in the ultimate division of the vessels, and sensibility of the nerves, circumstances that altogether escape us; so, till we explain this, it is in vain to speak of the other.

LVII.

Chemical Analysis of the Pancreatic Juice.

The quantity of pancreatic juice secreted, seems equal to three times the quantity of saliva; and, by chemical examination, the nature of the saliva and this secretion are found to correspond, as far as can be judged from smell, taste, colour, and consistence.

Analysis of Contents of the Chylopoetic Viscera.

Having now demonstrated the chylopoetic viscera, and their assistant organs, which pour their different secretions into them, it is proper to examine chemically

their contents, consisting of the chyme, chyle, and fæces.

Chyme.

Chyme is the product of the undigested food in the stomach. It is of a cineritious or yellow colour, and of a pultaceous, soft consistence. From the nature of vegetable and animal matter, as food, its principles most consist of;

1. The alible parts of such matter-reduced into a pulp, or a soft mass.
2. Those parts of it which remain undecomposable.
3. A union of saliva, gastric fluid, and mucus along with them.

In this state it must pass from the stomach into the small intestines.

Chyle.

The chyme in the small intestines is separated into two parts, chyle and fæces.

The chyle is a whitish liquor, of a sweet taste. It much resembles milk, but is of a thinner consistence; and its resemblance to milk appears still stronger when it is more fully examined.

The quantity of chyle depends much on the nature of the food, but from 5 or 6 lbs., little more than $\frac{1}{3}$ of this product is elaborated.

The constituent principles of chyle are much the same with those of milk, consisting of a serous, oily, and coagulable part. Thus there is obtained from it;

1. Water, which is its greatest proportion.
2. Oily cream, a combination of hydrogen and carbon.

3. Cheese, or coagulum, formed from the carbon and azote of the food.

4. Earth, for calculi, are found in the thoracic duct and lacteals.

5. Animal lymph, as mixt with the juices of the intestines.

From this view, chyle seems milk in a preparatory state, or possessing less of the coagulable or animal principle, which becomes perfected on its entering the thoracic duct, from its mixture with the contents of the lymphatics poured in here.

Fæces.

The fæces are a yellow or brown mass of various consistence in different parts of the intestines, and expelled in a form moulded by that of the part they pass through. They consist of the undigested part of the aliment mixed with the bile and secretion of the intestines. They possess a disagreeable and peculiar odor, differing in different animals. They first appear in the cæcum, and are said to discover a sweet taste. Their quantity, daily, is not less than 4 or 5 oz, but this is regulated by the food, vegetable food affording a larger proportion than animal food.

The constituent principles of the fæces are;

1. Water, for distillation, reduces them to $\frac{1}{12}$ of their weight.

2. A fœtid principle affecting the nostrils.

3. Inflammable carbonated air, which, on being set on fire, burns with a bluish green flame.

4. The indigested remains of the food, which the bowels cannot act upon; and

5. The mixture of intestinal excretions, viz. bile, enteric and pancreatic juice, mucus, &c.

From this view, the saliva and gastric juice in the stomach make the preparatory change on the food by converting it into chyme, or give it the separable state of its alible principles. Thus, to take an example, milk is coagulated in the stomach in order to separate its principles as the first step of digestion. In the intestines, the bile and pancreatic juice make the subsequent alteration, by uniting these alible principles into a fluid or chyle, and separating from this fluid the indigestible part, or feces; and, in the thoracic duct, this fluid or chyle is perfected by its mixture with lymph, or the contents of the lymphatic system. From the thoracic duct it next passes into the general circulation, where the process of respiration, as already noticed, bestows on it the perfect animalized state.

Lymph, then, would seem the fundamental preparatory menstruum which is kept ready by the system to be poured out in a variety of places, as the aliment descends in order to be united with it; for we find, on examination, that the saliva and pancreatic juice, and that the lymph, as far as we can judge by examination, agrees with each other in their nature.

The exact quantity of the excretions for the purposes of digestion or chylification, it is difficult to determine. For each meal, it is computed there is 6oz. of saliva; of bile, from the size of the liver, that there is not less than 24 oz.; and of pancreatic juice, there is 3 oz. The weight of these organs is rated at 3 lbs.

12 oz. to the liver, 3 oz. to the pancreas, and 14 oz. to the spleen. The flow of bile from the liver is greatest when the stomach is distended from the pressure of the organ against the stomach, and the reverse of this takes place with respect to the gall bladder, which has its fluid pressed out by the distension of the duodenum.

Thus the bile is the menstruum that, by its combination, separates the chyle and fœces, prevents the absorption of the latter along with the former; and, by its irritation of the intestinal canal, hastens its exit from the body.

During these processes going on in the stomach and intestines, these organs are never destitute of the presence of gases. In health, the quantity is small, but they are accumulated by disease.

Gastric air, when examined, has been found to consist of a mixture of four different kinds.

1. Carbonic acid gas, which is most in the stomach, and in small quantity in the intestines.

2. Vital air, contained chiefly in the stomach and intestines.

3. Azote, and carbonated inflammable air, contained in the large intestines.

As the presence, then, of the carbonic gas and vital air is greatest in the stomach and small intestines, so these gases are the fundamental principles of the chyle. Thus carbon, united with hydrogen, forms the oily or creamy part; and carbon, with azote, the cheesy or coagulable part.

LVIII.

From the moveable, which we have now examined, we proceed next to what are termed the fixed viscera of the abdomen; the first of which is the kidneys.

LIX.

The kidneys are two glandular bodies, of a pale red colour, situated on each side of the vertebræ of the loins, on the posterior part of the abdomen, upon the two last ribs. The right kidney lies under the great lobe of the liver, and is consequently lower than the left one, which lies under the spleen. The concave side of the kidneys is turned inwards to the vertebræ, and the convex side outwards.

LX.

The kidneys possess numerous connections. The right one is attached to the liver and duodenum by means of cellular substance, and its peritonæal covering. The left one is connected to the spleen by the same means, while both are united to the muscles on which they are placed, and also to the renal glands and colon. From these connections, they accompany the motions of the liver and spleen in the different states of respiration.

LXI.

The size of the kidneys is about five or six fingers' breadth in length; but it is considerably

less from the outer to the inner side, and still less from before backwards. Hence it has been compared to a kidney bean. The disposition of the vessels distinguishes the right kidney from the left when taken out of the body.

LXII.

Each kidney is surrounded by a covering of loose cellular membrane, within which is contained a considerable quantity of fat; and this covering invests both the kidney itself, and also its large vessels, so as to defend them from the pressure of the surrounding organs. On the removal of this covering, the proper coat of the kidney appears, consisting of two layers, its proper membrane, and condensed cellular matter, which form a strong adhesion to it, and are reflected over the edges of the sinus, to be joined to its pelvis and large vessels.

LXIII.

The substance of the kidney is commonly described as smooth and uniform; and where an irregularity takes place, it is in consequence of its original lobes not properly incorporating. It is divided into two parts, a cortical or external part, and a medullary or internal.

LXIV.

The cortical, or secreting part of the kidney, surrounds it so as to form a third of its breadth;

and, by its processes, or partitions, the medullary parts are separated from each other. The medullary, or uriniferous part of the kidney, is distinguished by its redness and distinct columns; and these columns terminate in its papillæ, or mammary processes. These papillæ are connected to each other by cellular membrane; they form a continuation of the uriniferous part; their number is uncertain, amounting from eight to seventeen, and depending on the number of original lobes of which the kidney is composed, and also on the incorporation of some of the papillæ with each other. The points of the papillæ compose the terminations of the uriniferous tubes; and these terminations through which the urine distills, are distinct to the eye. From the root of each papilla originates a membranous tube, termed the infundibulum, to receive the discharge. The number of these tubes correspond with the papillæ, unless where more than one papilla opens into the same tube.

LXV.

In their progress, these tubes, or infundibula, unite into larger trunks, two or three in number; and by the expansion of these trunks, a cavity of considerable size is formed; answering to the shape of an inverted cone, and constituting the pelvis of the kidney. In point of situation; the pelvis is, for the greater part, without the body

of the kidney; it contracts at last into a long tube, distinguished by the name of the ureter. One of these tubes is appropriated to each kidney: but they have been occasionally met with double in one or both kidneys. In their descent, the ureters pass obliquely behind the peritonæum; and this obliquity is also observed in their insertion into the bladder, which hinders the return of the urine from them. In their passage downwards, the ureters go over the great psoas muscles and iliac vessels, at the fore and lateral parts of the sacrum. Their termination is in the under, outer, and back part of the bladder.

LXVI.

These tubes, in the course of their descent, have been compared to the letter *f*; and they occasionally suffer dilatations and contractions, which occasion some change of their cylindrical shape. These contractions occur chiefly in their course over the psoas muscles, and their insertion into the bladder. The structure of the ureters is formed by three coats. The first is simply a peritonæal covering; the second is of a muscular nature, and formed chiefly of circular fibres; and the third, or internal, is villous, consisting of vessels and small excretory ducts, supplying a discharge of mucus to defend their surface from the urine.

LXVII.

The circulation of the kidneys requires next to be traced. Each kidney possesses one or more arteries derived from the aorta, and the corresponding vein or veins terminate in the cava. The entrance of its vessels into the kidney takes place at its sinus, and they are enveloped in a cellular substance during their course. Of the arteries, the right one is longer than the left, from the circumstance of the vena cava being placed at the right side of the aorta.

LXVIII.

In its approach to the kidney, a division of the artery takes place into branches, which are extended to extreme minuteness through the cortical substance in the form of arches and anastomoses; and the termination of this distribution of them, after various turnings and windings, is partly on the surface of the kidney, when they assume an irregular star-like form, and partly internally, where they pass in a waving direction, and assume an appearance somewhat similar to clusters of small berries, visible only by injection, or the assistance of glasses, and termed in this form, corpuscles.

LXIX.

In the same manner the veins, on their return from their arterial extremities, unite in the cor-

tical substance of the kidney; and the branches of the vein, though they correspond with the artery in their course, are much larger. They terminate on each side in a trunk, which enters the cava in a transverse direction; and the left vein is the largest of the two.

LXX.

From the extreme arteries, or corpuscles, the uriniferous tubes take their origin, already described as seated in the cortical substance: they form with their small vascular congeries the medullary portion of the organ. In their course they unite into larger tubes, which assume in their passage a radiated form, or run from the outer to the inner part of the cavity, and at last extending in their size, they terminate in the conical papillæ already described.

LXXI.

Renal Capsules.

Above the renal vessels are situated the appendages of the kidneys, or what are termed the renal glands. They are two small flat bodies, of a dark yellow colour. In their appearance they are glandular, and lie over the upper and fore part of the kidneys. Their figure is irregular; their length about two inches: but their size is greater in proportion in the fœtus than in the

LXXII.

These bodies are enveloped in cellular substance similar to the covering of the kidney, and, like it, they possess also a proper coat of a thin texture, and firmly adhering to it. Their connections to the contiguous parts are numerous. The right one joins the liver, the left one the spleen and pancreas; and, by the intervention of cellular substance, they are both attached to the diaphragm, the psoas muscles, and kidney. In their structure, these glands are frequently found hollow, and they contain a dark-coloured or bilious matter. Their circulation is supplied by the adjacent organs; their arteries from the renal aorta and diaphragmatics; and their veins terminate, the right one in the cava, and the left one in the renal vein.

LXXIII.

The use of the kidneys is evident by their secretion: but the use of the renal glands is still undiscovered, and has given rise to various conjectures. From their particular situation, it is probable they are subservient in their office to the kidney, in the same manner as the spleen is to the liver, and the pancreas to the parotids.

LXXIV.

Bladder of the Urine.

The termination of the ureters we found to be in the bladder of the urine, which is a large bag, situated in the pelvis, or at the bottom of the hypogastric region. This organ, when empty, contracts to a small size, and occupies simply the under and fore part of the pelvis; but, on its distension, it rises above its brim, and sometimes ascends to nearly the height of the navel. The figure of the bladder varies according to the degree of its dilatation. When moderately distended, it displays an irregular oblong form, more capacious below than above.

LXXV.

This organ is divided into three parts; its fundus, its body, and its neck. The situation of the first being upwards and forwards; and of the last, at its fore and under part.

LXXVI.

The attachments of the bladder are numerous to all the surrounding parts. Below, it is connected with the rectum. The peritonæum, and cellular substance, join it laterally to the pelvis in the form of ligaments. To the pubes it is attached by cellular substance alone; to the umbilicus it is fixed by the remains of the umbilical vessels, and the urachus running up from its substance.

But its firmest connection is a ligamentous expansion running on each side of its neck, and fixing it to the internal arch of the pubes, where the urethra also connects it to the penis.

LXXVII.

The bladder, like the other organs, possesses several coverings connected by cellular matter. The first is its peritonæal coat, passing from the abdominal muscles to it; and, when the bladder is much distended, from its connection with the peritonæum, it carries it with it, leaving a space between that membrane and the pubes.

LXXVIII.

The second, or its muscular one, is the most important coat of the bladder. It is formed of fleshy fibres, so interwoven as to form fasciculi. The external division of these fibres observes a longitudinal direction, and is connected at its under and fore part with the bones of the pubes; but, internally, its fibres form a net-work, and observe no particular direction. At the neck of the bladder, these fibres, by their contraction, form the sphincter. It is by the action of this coat that the discharge of the bladder takes place; and, by the separate action of the fibres of the neck from the fundus, an involuntary emission of the urine is prevented.

LXXIX.

Between the muscular and inner coat, the intervening cellular coat has been often considered as a distinct one; but for this there is no proper foundation.

LXXX.

The inner coat, or, as it is termed, the villous one, is a thin and smooth covering, somewhat unequal by the projection of the muscular fibres, and formed into rugæ when the organ is empty. This coat is possessed of much irritability; and the irritation of the urine excites it strongly at times to act. Hence, to guard against the discharge, it possesses a mucous secretion to blunt its acrimony, so as to prevent its being stimulated for the most part till the distension of the organ also co-operate.

LXXXI.

At its under part, the bladder is perforated in three different places. The anterior perforation is the commencement of the urethra, being surrounded by the neck of the bladder, and coming off at a right angle from its under part. The two other openings are situated behind, and form the terminations of the ureters. They are placed at a little distance from each other, and observe an equal distance from the beginning of the urethra as they do the one from the other. Their opening is somewhat of an oval form, and

more contracted than the space of the ureter immediately above.

LXXXII.

The circulation of the bladder is supplied from various sources. Its arteries are chiefly from the umbilical and pudenda communis, and its veins terminate in the internal iliacs, which form a plexus of considerable size on each side of the bladder.

LXXXIII.

The secretion from the kidney is transmitted to the bladder through the ureters by drops, or small thread-like streams; and, when accumulated, the quantity and actimony of the secretion forces the organ to contract in order to expell it. In doing this, the action of the organ itself is also assisted by the abdominal muscles and diaphragm pressing the bowels against the organ. The frequency of this operation depends on a variety of circumstances, as the size of the bladder, its degree of sensibility, the quantity of the urine, and its irritating quality.

LXXXIV.

From this view of the urinary organs, the kidney appears defended by a quantity of fat from the pressure of the abdominal viscera, and by the like means it is defended from the lumbar vertebræ, which lie behind, the tunica adiposa being upon the back part as well as the fore.

There is next a proper membrane, not derived from the peritonæum, connecting the several lobes that is found in the fœtus, and it is in a considerable degree formed of cellular substance condensed, but not entirely, for the inner side of it has the same smoothness as a portion of the peritonæum. When the kidney is cut into, two substances are observable. First, the cortical glandular, or vascular part. From this part tubes are sent inwards; and as they are collected from the whole surface, they give the cortical appearance. At their end we find the papillæ, from which the urine is discharged into the pelvis of the kidney; and the papillæ project into the kidney, to give room for more ducts, and also that the urine may not regurgitate, or be pushed back into the mass of blood; so that the more the pelvis of the kidney is distended, the sides of the papillæ are the more compressed.

LXXXV.

As the kidney is originally composed of a number of different lobes, there appear many infundibula uniting into one common duct, like branches of veins collected, and there is no certain rule, with regard to the number, or manner of joining; in some infundibula there is a single papilla, and in some two, &c. and also the number of infundibula varies.

LXXXVI.

From the pelvis of the kidney, the urine passes down to the ureter, where it gets the conical shape from the number of canals forming it. Thus stones may more readily form here, and where they do, they may not get down through the narrow ureter, but may remain in the kidney. The ureter is not entirely cylindrical, but varies in its size, and that in different places, for which no cause can be assigned, except at the turn where it gets into the pelvis; and this explains the various motions of a stone in the ureter. At the lower end, it passes so obliquely into the bladder as to serve the place of a valve, and at the same time the mouth is contracted, so that a stone may readily be interrupted at its entrance; this in women gives room for an operation, by which the life of a person may be saved. The ureter has a thin coat of the muscular kind, and another dense and smooth coat within it, and the action of the ureter may be seen very distinctly, contracting itself like a worm upon a very slight irritation. It is material to observe this, that it is not to be considered as a mere membranous tube; and in the case of the descent of a stone, we see the advantage of giving opium, for, by lessening the pain, the spasm is taken off, and the relaxation of the muscular coat lying upon it, by which means the urine may push on the stone into the bladder.

LXXXVII.

The bladder is of a curious and complex structure; and here the common opinion, with regard to the extent of muscular contraction, is contradicted; for the bladder can contain 2lbs. of urine, and its fibres are at the same time capable of contracting so in all directions as to expel every drop of this, which shews that muscular fibres possess a very extensive power.

LXXXVIII.

Nor is there observable any particular muscle serving as a sphincter, and yet we possess two opposite powers of pushing the urine out, and stopping it, at pleasure; and hence muscular fibres can act so that one part of the fibre is an antagonist to the other, or we can employ parts of fibres to perform an office; we can relax the one part, and employ the other; and that it can be done alternately. The internal coat of the bladder is very dilatable, so may be pushed out by a stone, between the fibres of the muscular coat, in which case there will be difficulty in extracting the stone.

LXXXIX.

The name of villous, applied to the inner coat of the bladder, which is smooth, is evidently improper. We do not find all the fibres in the muscular coat running from the mouth of the

fundus, but many of them run obliquely; and we can only say, that many bundles of fibres begin at the neck, run up to the fundus, come down upon the opposite side, and cross a little when they reach the neck; or that we find the fibres very fitly disposed for contracting the bladder into all its directions. The description, therefore, of a distinct spineter muscle is improper; all that can be demonstrated is, that the circular fibres grow a little thicker, and the longitudinal and oblique decussate each other, but without forming a complete circle, as is observable at the pylorus, or without there being any distinct muscle, as we find at the extremity of the intestinum rectum.

XC.

Chemical Analysis of the Urine.

The secretion of the kidneys, or the urine, is divided into the crude or costed. The former being an immediate discharge after food or drink, and therefore copious, and occasionally vitiated by certain impregnations; the latter thicker, more coloured, and acrid, and emitted in the morning after sleep.

This discharge is of a citrine or straw colour, possesses a temperature equal to the blood, is saltish and nauseous to the taste, and in its consistence thicker than water.

Its quantity is regulated by the quantity of fluids taken in, and the state of the season.

By the usual tests, urine discovers neither an acid nor alkaline nature. By farther experiment, it is proved

entirely an aqueous, not a serous fluid; and, by its evaporation, its chief products are compound salts.

The progress of urine to putrescency, is more rapid than that of any of the other animal fluids, and its changes in the open air, in passing to this state, deserve attention. On its first discharge, it remains pellucid for some time; but, at last, there appears at bottom a small cloud, or marks of a consolidated gluten, which thickens and increases till it occupies the whole vessel, and renders the urine opaque. As this process advances, the smell of the urine is changed, becoming putrid and cadaverous, and a cuticle is formed on the surface of the vessel, composed of minute crystals.

The urine next regains its transparency, and acquires a brown, instead of its yellowish colour. Its smell also changes to an alkaline nature, and a brown grumous sediment is deposited at the bottom filled with white particles subject to deliquescence, and so conglutinated, as to resemble soft calculi. In this state the urine effervesces with acids.

By evaporation of 36 oz. of urine, one ounce and a half of residuum is procured, containing the following proportion of ingredients. Muriatic salts, 1 dram. Phosphoric salts, 3 drams, 50 grains. Uric acid, and phosphate of lime, 25 grains. Animal extractive matter, 3 drams, 40 grains.

Thus the recent urine contains an excess of phosphoric acid, which it soon loses for the prevalence of ammonia; but, of all its ingredients, the most remarkable is the uric, an excrementitious substance surcharged with nitrogen, the excess of which it carries off from the body.

The general constituent principles of the urine are ;

1. Water, in such a proportion, that from 20 oz , 19 of this fluid were obtained.

2. An odorous principle, perceptible to the smell,

3. Phosphorated soda, as ascertained by calcination of the dry extract, and its solution in water.

4. Phosphorated ammonia, which is ascertained by allowing a solution of calcined extract of urine in spirit of wine to crystallize the microcosmic salt of urine, is found consisting of ammonia, soda, and phosphoric acid.

5. Calculous matter, in the form of a brownish red earthy gluten, and consisting of gluten, animal earth, and uric acid, as displayed by the analysis of calculi.

6. The extractive principle of urine, or uric ; and,

7. Compound salts ; as, muriate of potash, and muriate of soda.

No animal fluid is subject to so much variety as the urine, and this happens from the effect of

1. Age ; for its acrimony gradually increases with the progress of life.

2. Drink ; for cold and copious draughts render it pale ; while green tea, cassia, pulp, render it green.

3. Food ; for asparagus or olives give it a peculiar smell, and fasting renders it turbid.

4. Medicines. Thus rhubarb gives it a yellow tinge, and turpentine a violet colour.

5. Period of season ; for, in winter it is copious and aqueous ; in summer, sparing, high coloured, and acrid : an influence equally displayed also by the climate.

6. Muscular action; for, by motion its secretion is lessened, and increased by rest.

7. Affections of the mind. Thus fear renders its secretion pale.

Anatomical Preparation of the Mesentery.

In order to inject its vessel, proper care must be taken to secure their extremities. When this is done, one of the largest arteries and veins near the root of the mesentery should be chosen, and into them proper pipes fixed, and the injection conducted with two liquors of different colours. The injection will enter every part of the mesentery and intestines freely, in consequence of their numerous anastomosis.

Anatomical Preparation of the Kidney.

For injection, a kidney as sound as possible should be chosen, and there are three orders of vessels in it to be injected in order to shew their ramifications by corrosion. The artery here is distinguishable by its greater thickness and elasticity, and also by being generally smaller than the vein; and the duct is known by its enlargement near its entrance into the kidney. Proper sized pipes then being fixed into the different vessels, proceed according to the directions given in the other organs, to fill each set of vessels with a different coloured injection; and, after the pipes are removed, the kidney is to be immersed in the acid solution for five or six weeks, till the texture of every part is destroyed, and may be washed off from the corroded preparation.

For the purposes of injection, the kidney should be carefully removed from the body, and no part of it wounded, or any of its fat removed.

XCI.

Having now pursued the descending aorta, or vascular distribution through the thorax and abdomen, before examining the organs peculiar to the sexes, or tracing the circulation of the extremities, it is proper to return and view that of the upper parts, as carried on by the ascending aorta.

XCII.

From the arch of the aorta, which they entirely occupy, come off three great arteries that rise to the head, or decline laterally towards the arms; and by them are nourished all the upper parts of the body. The first of them is the right carotid and subclavian, formed by its divisions above the arch about an inch. The second is the left carotid, going to the head; and the third is the left subclavian, going to the left arm.

XCIII.

We shall examine the distribution of the carotid artery first. This artery having emerged from the thorax, runs up along the neck by the side of the trachea, in one division, till it touches the lower jaw. In this course it constantly recedes from the fore part of the throat, getting gradually deeper till protected by the projection of the larynx. It divides, at the jaw, into two branches, termed the external and internal carotids; the one going to the outside of the head, the

other to the brain. And, in order to understand the circulation here, it will be necessary to examine first the general structure of the several organs these particular vessels are destined to supply.

XCIV.

Brain.

The first, and most important of these organs, next to the heart, is the brain, or origin of the nervous system. It is that mass which, with its inclosing coverings, fills the cavity of the cranium; and in the human subject, it exceeds in proportionate size to the brain of every other animal.

XCV.

The coverings of this part consists of three membranes. The dura-mater, arachnoid coat, and pia mater.

XCVI.

Dura Mater.

The dura mater forms the external inclosure, and is the means of connecting this organ to the cranium, which it lines. Though but a single membrane, it is in several places divisible, by maceration, into layers.

XCVII.

In its texture, this membrane possesses considerable density, and may be considered as the thickest and strongest in the body, approaching somewhat to tendon in the strength of its fibres. Its adhesion to the surface of the cranium is

equally strong as that of the periostæum to the bones elsewhere; and this adhesion is particularly firm at the futures and openings, or foramina, and is even stronger in childhood than in age. On its external surface it forms a smooth lining to the brain, only attached at the place where the veins are expanded into sinuses, and it is everywhere lubricated by a serous excretion from its vessels.

XCVIII.

By the secretion of the fluid of this membrane, the different states of respiration are prevented from injuring the organ; and, similar to the periostæum of the bones, it forms both a defence to the brain, and conveys nourishment to the internal layers of the skull. By it, also, the situation of the brain is preserved steady, and various processes proceed from it, which divide the brain into certain parts.

XCIX.

Thus, when the cranium is circularly cut, there is found a very considerable adhesion of the dura mater to it; and, when it is drawn asunder, we observe a great number of red points which are the extremities of lacerated vessels. Hence we conceive that the dura mater serves as the external periostæum to the inner table of the skull; and the use we assign to it is, that of supplying the bone with vessels. Hence, in performing opera-

tions, as in the trepan, we should be extremely cautious not to detach more of it than is absolutely necessary; and for the same consideration that we avoid to scrape the periostæum from a bone, viz. least we should bring on a caries. It is farther observable, that there can't be no such motion of the dura mater as was formerly alleged; and, upon attending to the communication which the vessels upon the opposite side of the skull have with each other, it appears probable that the affection of the external membrane may disorder the dura mater, but not, however, in such a degree as has been supposed. Where the pericranium is separated with violence, the dura mater will be detached too, but this is not from the communication of the vessels, but from the same violence affecting both; but, in such cases, we frequently find the dura mater adhering. As the thickness of the dura mater is more considerable than the external periostæum, it may serve also, as observed, like a soft cushion to defend the very tender substance of the brain.

C.

The processes of the dura mater are three in number; the superior longitudinal process, or falx; the lateral one, or transverse septum; and the minor falx, or syplum of the cerebellum.

CI.

- The 1st is that doubling of the membrane which separates the brain into two hemispheres, commencing at the middle of the sphenoid and ethmoid bones, and pervading the upper and middle part of the head, along which course it possesses adhesions to the different bones, being straight in its direction, and in shape resembling a falx or sickle, expanding at the same time gradually in its progress from the cranium to near the corpus callosum, and terminating behind in the middle of the tentorium. It is this process that supports the tentorium, and thus prevents the pressure of the two sides of the brain on each other.

CII.

The 2^d, or transverse septum, runs from the former to the os petrosum, and is connected behind to the inner transverse ridges and grooves of the occipital bone, terminating at the posterior part of the sphenoid bone. This process forms a arch or vault over the cerebellum, and prevents the pressure of the cerebellum upon it.

CIII.

The 3^d, or central septum, is placed between the lobes of the cerebellum. It descends from the under and back part of the falx, and adheres to the inferior longitudinal spine of the occipital bone, and terminates at the edge of the foramen magnum.

CIV.

Besides these, small processes of the dura mater pass out at the different openings of the cranium, which are of less importance, but which all serve to connect it with the adjacent parts.

CV.

From this situation of the septa, and there going down a considerable way betwixt the hemispheres of the brain, and from observing the appearance of the dura mater, there is some foundation for saying that this is a double membrane, the two layers of which adhere very closely, and the middle parts are softer, and connected by strong cellular threads. In the same manner, when the brain is raised from the cerebellum, there appears a similar membrane stretched between them, all which evidently prevent one part of the brain from gravitating upon the other in the different postures of the body, while these two membranes, viz. the falx and tentorium, mutually support each other; and, in some very large and swift animals, we find the partition formed of bone. Not satisfied with covering the brain, we find that the dura mater runs down into the spine, serving the same office to the spinal marrow as to the brain in general; and, lastly, we observe where the nerves go out to the external parts, that membrane is wrapt close about them.

CVI.

The circulation of the dura mater is chiefly from the external carotid, the internal one, and the vertebrales, as we shall afterwards find; but what is only to be noticed here is, the particular termination of its veins in sinuses, for the transmission of the blood from the head to the neck. These sinuses are formed by a tense doubling of the membrane over them, so as to be little affected by the pressure of the adjacent parts.

CVII.

These sinuses are chiefly distinguished by the strength of their coats, and their frequent communications; and their situations are,

1. The superior longitudinal one, which beginning at the crista galli of the ethmoid bone, directs its course along the upper edge of the falx, enlarging in its progress, and terminating in the lateral sinuses. -

2. The torcular of Hierophilus, which runs between the falx and tentorium, and terminates with the former sinus in the beginnings of the lateral ones.

3. The two lateral sinuses formed by the longitudinal and torcular ones, which observe a varied course, first running transversely, then in a winding direction downwards, observing the depressions of the occipital and temporal bones, till they

terminate at the base of the cranium, in the beginning of the internal jugular veins.

CVIII.

Thus the sinuses are the trunks of veins covered by the dura mater, and small branches enter at the sides of it. We shall afterwards find several useful purposes served by this structure, that the veins are greatly strengthened by it, and several dangers thereby avoided; and, as the small branches pass obliquely through the dura mater, this oblique passage serves the office of valves.

CIX.

On the sides of the sinuses, and elsewhere on the dura mater, small granulations are apparent, of a whitish, and also of a fleshy colour, the use of which is unknown.

CX.

Arachnoid Coat.

The second covering of the brain is the arachnoid coat, so named from its resemblance to a spider's web. It forms a very thin transparent membrane without any appearance of vessels. Its expansions seem confined entirely to the surface of the brain, and it insinuates itself no way into its substance or convolutions.

CXI.

The adhesion of this membrane is greatest at its upper part, where the connection by cellular substance is so strong, as hardly to bear separa-

tion ; but in other parts it appears to lie merely in contact, and is easily raised from the other parts.

The use of this membrane is like the former, to cover and defend the parts over which it is spread.

CXII.

Pia Mater.

The third covering of the brain, the pia mater, somewhat resembles the former in its tenderness, but possesses vascularity. It differs however from it, besides being a covering, in its insinuating itself deep into every part of the substance of the organ, and it forms the lining of the ventricles. It is in this membrane the vessels of the brain are contained, and by it they are supported and allowed to separate into the minute divisions which are necessary for its circulation and functions.

CXIII.

The circulation of this membrane we shall afterwards trace. It is only remarkable in so far that its veins do not accompany its arteries.

CXIV.

Brain, or Cerebrum.

The brain is divisible into four different parts, the chief of which are the cerebrum and cerebellum. The cerebrum completely fills the upper part of the cranium, and is divided into two halves, termed its hemispheres, that are preserved separate by means of the falx.

CXV.

Each of the hemispheres displays an oval form; the inner sides of which are flat, and the upper and outer convex, while the inferior surface is irregular. Hence it is divided into two anterior, two lateral, and two posterior lobes or processes.

CXVI.

The situation of the first of these is in the fore part of the cranium; that of the second in the depressions or pits formed by the temporal and sphenoid bones; and that of the third over the cerebellum, from which they are separated by the tentorium. Between the first and second there is a conspicuous furrow formed by the anterior cleftoid processes of the sphenoid bone, termed the large pit, or fossa of Sylvius.

CXVII.

In examining the surface of the brain, it is divided into numerous windings or turnings, termed convolutions. These run in various directions. They are also of different sizes and lengths in the several parts of the brain. A connection between them and the pia mater is every where conspicuous by the intervention of small vessels entering the substance of the brain; and, to detect this, it is necessary to make a slight separation of the convolutions from each other.

CXVIII.

The evident purposes of these convolutions is to increase the external surface, in order to give room for the very minute divisions of the blood vessels; for the pia mater, or vascular membrane, descends between each of the convolutions, and the several doublings of the pia mater are kept together by the very fine coat without vessels. The arachnoid is connected to the pia mater by cellular substance, and we may consider it likewise as defending the very tender vessels of the pia mater. Perhaps, farther, the arachnoid coat may prevent the concretions better than a membrane, with a great number of different vessels, and we find that nature guards against the contact of the dura mater with the surface of the brain, by the interposition of a liquor. If that liquor should at any time be collected in an unusual quantity, so as to form a Hydrocephalus internus, the water would fall down into the spinal marrow, between the two membranes, in consequence of which the vertebræ may be pushed outwards, so as to give the appearance of the spina bifida.

CXIX.

Between the hemispheres is observable a white medullary substance, somewhat firmer than the texture of the brain, named the corpus callosum. It crosses the brain immediately under the falx,

and running horizontally, joins the the two hemispheres to each other. Its middle is marked by a longitudinal raphe, and on each side of it a medullary chord, giving origin to many transverse streaks.

CXX.

On cutting into the brain, immediately on a line with this corpus callosum, the substance of the organ discovers a division into two parts, an outer or cortical one, and an inner or medullary one. The first receives various appellations, being named cortical, from its manner of surrounding the medullary part, or being, as it were, the bark of it. It is termed cineritious, from its grey or ash colour; and it is styled also glandular, or secretory, from its supposed functions. The extent of this part is general over the brain, it passes deep between its convolutions, and is a congeries of vessels conveying its circulation without the appearance of any particular fibrous texture.

CXXI.

The medullary, or white part, is regarded as the origin of the nerves, and has been termed, from its supposed structure, the excretory duct of the brain. It differs from the other part, by exceeding it both in quantity and firmness of texture; but so intimately are they connected, that it at the same time appears but its continuation. Its fibres run in a parallel or transverse

direction, and the medullary and cortical parts are found in different places blended with each other. On these two different substances of the brain we observe that the cortical or cineritious substance is by no means so thick as we are apt to conceive it; the deception is owing to the convolutions of the brain, the thickness being only about $\frac{1}{8}$ part of an inch.

CXXII.

The cortical substance has every where the pia mater immediately applied to it, then the medullary substance is every where connected with the cortical, so that we cannot shew medullary fibres without being able to trace these back to a cortical substance, or a cortical substance which does not form medullary.

CXXIII.

Thus there prevails a strong connection between the pia mater and the cortical substance of the brain, the vessels of which it is evidently intended to conduct: for, if a section of the brain is examined, the vessels of the pia mater appear lodged perpendicularly into the cortical substance. Not that it can be proved entirely made of vessels, for a considerable part of it still retains its former appearances. Connected to this appears also the medullary part, which is of a fibrous nature, and the direction of the bundles of fibres can be traced, and that the nerves are its continuation.

But, where they leave the substance of the brain, without exception they are covered by the continuation of the pia mater, or a vascular membrane resembling that. And, if they are intended for the external parts, and to run along the muscular organs, there is another sheath from the dura mater, or one so like it, that it may be held the same.

CXXIV.

The fibres of the medullary substance can be seen with the naked eye, and it can farther be seen that the nerves are every where their continuation; but, at the same time, all the medullary fibres are not continued to form nerves; some of them are continued in a direction that is the most unfavourable to the formation of nerves, and the fibres that compose the substance of the brain and cerebellum is much greater than that of all the nerves joined together.

CXXV.

On removing the cortical part of the brain, a nucleus is formed by the medullary substance alone, termed the centrum ovale of Vieussens; and, to obtain a proper inspection of it, the nucleus should be cut so as to preserve the corpus callosum; and the same convexity is conspicuous as in the general surface of the brain. By this centrum ovale is formed the roof or vault over the lateral ventricles, and its smooth uniform under surface constitutes their upper part.

CXXVI.

The ventricles of the brain are four in number, lined with a fine smooth membrane continued from the pia mater, but with less vascularity than that membrane. These ventricles are composed of medullary matter, with their sides contiguous to each other, and having their cavity constantly moistened by a serous excretion.

CXXVII.

The lateral, or superior ventricles, run horizontally with the hemisphere in which they are situated, one to each. They lie under the centrum ovale, of an irregular form, with each three winding corners, termed cornua, from their resemblance to rams' horns.

CXXVIII.

The septum lucidum forms a separation between the anterior cornua. The posterior cornua, though situated at a distance from each other, and termed also digital cavities, at their pointed extremities approach nearer to each other. The inferior cornua observe a course downwards and forwards, so as to end in the lateral lobes of the brain.

CXXIX.

Each of the posterior cornua is distinguished by an elongation ending in a point, termed the hippocampus minor. In the bottom of the lateral ventricles two eminences are placed anteriorly, named

corpora striata, which gradually turn narrow, and recede from each other as they advance posteriorly to their termination. These eminences discover externally a cortical structure, but, within are mixed with medullary streaks, some of which form large transverse circles, and others observe a straight direction.

CXXX.

Between the corpora striata, at their posterior part, are situated the thalami nervorum opticonum, cortical without, and medullary and striated within. Upon the extremities of their surface are placed tubercles, or eminences. The thalami, internally, are flat and contiguous, and above their surface forms one close attachment, named the committura mollis of the opti thalami. In their course posteriorly, the thalami pass downwards and upwards; in which direction they become elongated into two white chords, named tractus optici.

CXXXI.

The thalami are covered by the choroid plexus, or a vascular membranous congeries, formed by the ramifications of arteries and veins connected by the pia mater, and spread upon the surface of the thalami and adjacent parts.

CXXXII.

Returning to the corpus callosum, under its raphe appears the septum lucidum, forming a partition between the lateral ventricles. The form

of this septum is broad before, narrow behind, and curved at its edge; and its connections are above to the corpus callosum, and below to the fornix.

CXXXIII.

The composition of this part is of cortical and medullary laminae. At their fore part they are separated from each other by the fissure or sinus of the septum lucidum. This sinus, however, affords no communication with the lateral ventricle, though at times it moves considerably backwards.

CXXXIV.

For the septum lucidum appears the fornix, a continuation of the corpus callosum; so termed, by the ancients, from its resemblance to a vault. From the hollow cavity which it forms, proceed four winding pillars, or cornua, two anterior, and two posterior. The two former are short, and closely connected in their course; the two last are long, more distant from each other, and correspond from their curvatures with the inferior cornua of the lateral ventricles. The thin borders of their under parts, situated within the latter, are termed corpora fimbriata.

CXXXV.

In its figure, the fornix is broad before and behind, where connected with the corpus callosum. The posterior part of its body below is impressed

with oblique lines resembling a lyre, and therefore named psalterium. The connections of the body of the fornix are above to the septum lucidum, below to the thalami optici, by means of a vascular membrane, named tela choroidea, which, spreading over the thalami, unites the choroid plexus of the lateral ventricles.

CXXXVI.

In the inferior prolongations of the latter are two medullary eminences, which take their origin from the sides of the corpus callosum, at its posterior extremity. These eminences are termed pedes hippocampi. They observe the same course as the pelleris, and have been supposed as forming part of them. They arise by a small origin, and gradually enlarge as they advance to their extremity. A medullary lamina forms their external covering, and their internal structure shews a convoluted appearance, composed both of cortical and medullary laminæ. The inner edge of the pedes hippocampi displays an indented margin, proportionally larger in quadrupeds, and less in man.

CXXXVII.

The openings of the ventricles are the next important part. The first is an oval hole, by which the lateral ventricles communicate freely with each other. It is placed at their bottom, behind the crura of the fornix, and the meeting of the choroid plexus.

CXXXVIII.

The second lobe is the iter ad infundibulum, or ventriculum tertius, seen on dividing and turning back the fornix. The third lobe is the foramen commune posterius, between the commissura mollis of the optic thalami and the pineal gland.

CXXXIX.

The third ventricle still remains, and it is only a deep fissure between the inner ends of the thalami optici, being bounded above by the commissura mollis, below by the crura cerebri, and on each side by the bodies of the thalami.

CXL.

A passage of considerable size, of a cortical and medullary structure, termed the infundibulum, comes next into review. It leads downwards and forwards, and gradually contracts till it becomes solid at its termination. This is in the glandula pituitaria, and thus it prevents the transition of any fluid from it to the nose.

CXLI.

The glandula pituitaria is of an oval form, about the size of a bean, of a brownish colour, formed of cortical substance, and mixed within with medullary matter. This gland is lodged in the sella turcica, surrounded by a doubling of the dura mater; and the use of it is completely unknown.

CXLII.

The next parts to be noticed are two medullary cords.

The first is termed *commissura cerebri anterior*, and is situated at the fore part of the third ventricle, running transversely through the *corpora striata*.

The second, shorter than the former, is the *commissura cerebri posterior*, situated at the back part of the third ventricle, under the root of the pineal gland.

CXLIII.

The fourth ventricle has a passage leading to it, under the name of *canalis medius*, from the back part of the third one; and next, in removing the posterior part of the fornix, and *tela choroidea* at this back part of the third ventricle, a number of peculiar divisions of the brain that still remain, come into view.

CXLIV.

The first of these is the nates placed uppermost. The second are the testes immediately below the former, of a white colour, broader from side to side than in any other direction. These tubercula are externally medullary, and within cortical. Their names are more proper in quadrupeds than in man, from their greater proportional difference of size.



CXIV.

Under the back part of the fornix, over the nates, is placed the pineal gland. It is a small cortical body, like a fir cone in shape, and in size like a garden pea, always present, and seldom found diseased; hence considered as the seat of the soul. This gland, at the root, is fixed to the posterior commissura cerebri, and sends out two long medullary peduncles, to be fixed to the upper side of the thalami, and anterior crura of the fornix. In the substance of the pineal gland, small calcareous concretions are observable after the age of puberty, termed *acervulus cerebri*.

CXLVI.

Thus within the brain are found many tubercles, and there seems to be a necessity some how or other, for reasons that perhaps we cannot conjecture, that the several tubercles be kept from adhering to each other; hence we find ventricles within the brain, and it is of use to observe these hollows for the sake of disease. We have seen their place and manner of communication; the two lateral ventricles communicate with each other under the anterior crura of the fornix; between these and the choroid plexus the communication is large enough to receive a large sized quill. At the same time they communicate with the third ventricle, the hole being open underneath; and the third, by the *iter ad quartum*

ventriculum, communicates with the fourth, so that it is pretty certain that the glandula pituitaria is of the same nature with the lymphatic glands in the rest of the body.

CXLVII.

From the cerebrum we proceed to its appendage the cerebellum. It is situated under its posterior lobes, separated from it by the tentorium, and occupying the inferior fossæ of the occipital bone.

CXLVIII.

Its size equals only about $\frac{1}{5}$ or $\frac{1}{6}$ of the brain. It is more simple in its structure, and somewhat roundish in its form. Like the brain, also, it is divided by the falx minor into two hemispheres, but possesses no separation above. Like the brain, also, it is marked by numerous convolutions in the form of arches decussating each other; and these observe a lateral direction, consisting of laminae with deep furrows; between each the pia mater is insinuated in the same manner as in the brain.

CXLIX.

Two middle eminences are marked out in the cerebellum, named appendices vermiciformes from their resemblance to an earthworm, one of which is placed anteriorly, the other behind.

CL.

The lobes of the cerebellum are also divided into smaller parts, lobules or monticuli, and vari-

ous names are assigned to these, according to their particular situation and connections. They admit some variety, and are chiefly distinguished by the direction of their convolutions.

CLI.

In substance, the cerebrum and cerebellum are the same, only the cerebrum possesses a greater proportion of the cortical part; and, from the peculiar distribution of the medullary laminae when the cerebellum is cut vertically, it displays the appearance of a branching shrub, termed therefore *arbor vitæ*.

CLII.

This medullary substance, when cut into, is laminated; and, at a considerable depth, there appears a *centrum medullare* uniting the lateral lobes as in the brain.

CLIII.

The next part that falls here to be described, is the fourth ventricle; the situation of which is between the cerebellum *tuber annulare* and upper part of the medulla oblongata, and it extends from the testes to the inferior notch of the cerebellum. As it descends from the testes it becomes wider, forming an angle behind, from which it contracts till it terminates in a point, termed the *calamus scriptorius*. Over the upper part of this ventricle is placed a thin medullary lamina, termed the valve; and at the side of this

valve, are two medullary tracts, termed *processus ad testis*. The under part of the ventricle is shut by its choroid plexus, so that no communication can take place between it and the spine.

CLIV.

Under Surface of the Brain.

Between the lateral lobes of the brain, at its base, are placed two small round white bodies, named *corpora albicantia*, being without of a medullary, and within of a cortical substance. In these bodies are the terminations of various medullary striata from different parts.

CLV.

Immediately before these bodies appear two white cords named the *pedunculi cerebri*, which originating from the medullary substance of the brain, gradually approximate in their course, till they unite in the *tuber annulare*. They are composed of medullary fibres, and possess, internally, a mixture of cortical and medullary matter; the former of which is so conspicuous at one particular part, as to give it a darker colour, and occasions it to be named *locus niger crurum cerebri*.

CLVI.

A cortical substance, termed *pons varii*, forms a junction of the opposite sides of the *crura cerebri*, and *corpora albicantia* together; and it further assists to compose the bottom of the third

ventricle. Two white cords also arise from the medullary part of the cerebellum, entitled the *crura cerebelli*; and with the *crura cerebelli*, they compose the *tuber annulare*, or *pens Varolii*, which forms a ring or bridge at it were over these *crura*. Thus the *tuber* is situated over the body of the sphenoid and cuneiform processes of the occipital bones. It is stretched along its surface, and divided by a longitudinal depression from the course of the vertebral artery into two lateral parts. It contains in its substance much cortical matter, the striæ of which observe various directions. Extending from the *tuber*, appears the *medulla oblongata*, a large substance in the form of an inverted cone, and reaching to the *foramen magnum* of the occipital bone. On its surface appear two small longitudinal contiguous eminences, named, from their shape, *corpora pyramidalia*, between which there is a deep fissure, penetrated by the *pia mater*, for the passage of blood vessels into the interior medulla. At the outside of these eminences are also two others, named, from their appearance, *corpora olivaria*; and still more externally are a third and less distinct pair, termed *corpora pyramidalia lateralia*.

CLVII.

The *medulla oblongata*, thus situated, is formed of medullary matter externally, and cortical within, joined by medullary; and it is divided by means

of an anterior and posterior fissure into two lateral portions.

CLVIII.

Thus we have examined the brain in its several parts, or that organ which is the source of nervous influence, the primary organ of sense with which the mind is supposed to be immediately and most intimately connected; we shall next pursue the detail of its circulation, which is also peculiar and important. We formerly traced the external carotid to the angle of the lower jaw. There it divides into two great branches; the first, preserving the name of external, is distributed on the outside of the head; while the second, the internal branch, passes, in order to give circulation to the brain; and, in doing this, it is assisted by two others, the vertebral arteries, which arise from a different source, or the axillary. By these arteries passing on each side into the head, an immense supply of blood is conveyed to the organ, and not less, on the most moderate calculation, than $\frac{1}{10}$ of the whole mass; and, as the arteries are large, and their action powerful, the violence of their circulation from being injurious to the soft texture of the brain, is purposely counteracted by a number of circumstances.

CLIX.

The 1st of these circumstances is the tortuous course of the arteries, as they pass into the head.

. The *2d* is the entrance of the carotid to the head through a long bony canal, giving resistance to its impulse.

The *3d* is 'the minute division of the arteries, and their dispersing on the pia mater before they pass into the substance of the brain; and

The *4th* is the thinness of the arterial coats in the brain from what they are elsewhere.

CLX.

With these peculiarities in the circulation of the head, the carotid, on entering it by the os petrosum, gives off three branches at the side of the sella turcica, which it first reaches.

CLXI.

Arteria Media Cerebri.

The *1st* is the middle artery of the brain, which is to be considered as the arterial trunk. It runs straight along the fossa sylvii, formerly described, and goes directly outwards towards the temple. In the fossa sylvii it divides into two branches, a deep and superficial one, but its main circulation is spent on the middle lobe of the brain. Previous to its lodgement in the fossa sylvii, it gives off some small delicate twigs, which are distributed to the pituitary gland, the optic nerve, the tentorium, and pia mater, at the cranial base. The chief of these twigs are the artery of the choroid plexus running up into the anterior horn of the lateral ventricles and the plexus of arteries, like sewing

threads scattered over the crura cerebri and base of the brain, and marked by their numerous anastomoses.

CLXII.

Arteria Anterior Cerebri.

The next division of the carotid is named the fore artery of the brain, which observes a straight course along the anterior lobe. It gives off branches to the olfactory and optic nerves. The branches then, of this artery, on each side meet, and form a communication just before the sella turcica and pituitary gland. From this part it dispatches a branch to the third ventricle, which gives off subdivisions to the fore part of the fornix and septum lucidum. Its two divisions then rise, and keep the course of that separation which the falx makes between the hemispheres, the one observing a deep, the other a superficial route.

CLXIII.

Arteria Communicans.

While the former artery goes to the fore, this one passes to the back part of the brain. It goes round the sides of the corpora mammillaria, and it soon meets the vertebral artery, and thus it forms, though itself a small artery, one of the largest and most important anastomoses in the body. This anastomosis is termed the circle of Willis; and the vertebral artery, thus connected, gives off three divisions; two to the cerebellum, and one to the back part of the brain.

CLXIV.

Vertebral Artery.

This artery arising from the axillary one, conveys much blood to the brain, and it observes the same course and precautions with the carotid before its entrance to the organ. On entering the foramen magnum, it soon meets its fellow, and the two unite into the basilar artery, which lies upon the cuneiform process of the os occipitis and the tuber annulare of the brain, which it marks with a furrow or depression, and in its progress it gives off small twigs to the adjacent parts. On the vertebral passing into the basilar artery, it sends off the lower artery of the cerebellum. It differs in its size on each side, and is sometimes wanting. It moves down in a retrograde course, and dives in between the cerebellum and medulla oblongata. When the vertebral artery arrives at the pons Varolii or tuber annulare, it sends off at once four arteries, two to each side of the brain. The first, or those to the right side, named *arteria cerebelli*, bend round the crura cerebri to get at the cerebellum, to which it gives branches aside to the vermis. The second, or those that pass to the left side, named *arteria posterior cerebri*, observe the same bending course with the former, and go into the division between the cerebrum and cerebellum, running up to the back lobes of the brain. They send off also numerous twigs in

every part of their course, and they inosculate with the middle artery of the brain, and that of the corpus callosum.

CLXV.

Thus by the internal carotid and vertebral arteries is the whole brain amply supplied with blood; of the membranes, the vessels of the pia mater are derived from the same source; but the dura mater, on the contrary, receives only a part from this quarter, and its chief circulation is from the external carotid.

CLXVI.

Having thus seen the distribution of the internal carotid, or chief cerebral artery, and observed also that it freely communicates with the vertebral one, there appears little danger of the stoppage of the blood in any part of the organ, and numerous examples occur of anastomoses between the internal and external arteries; hence, after tying the carotis communis, not only the functions of the brain continue, but also those of the external parts, the blood getting through the vertebral to the internal carotids, and from these into the external ones. From these communications it has been proposed, where the head seems to be oppressed with too great a quantity of blood, which is frequently a cause of apoplexy, perhaps also of epilepsy, to lessen the quantity by tying one of the carotids. Now, although, from

the vicinity of the nerves of the eighth pair and intercostals, this experiment is attended with a considerable degree of danger, independent of that from tying the artery; yet, surely, the idea is worth pursuing in other animals; so in the staggers, or epilepsy in a horse, we might tie one of the carotids to see the effect.

CLXVII.

Next, attending to the situation of the carotids with respect to each other, the internal is sent off at an angle, and the external is the more direct continuation of the trunk; and the vertebral arteries arise at a right angle, and form the subclavian. We find that both the arteries which supply the brain come off in an unfavourable manner.

CLXVIII.

When we prosecute the particular branches of the external carotid, the first branch is sent to the larynx, and then turning downwards, it enters the thyroid gland, where it freely communicates with an ascending artery; and, examining the structure of the gland, we find that a great quantity of blood is circulating here. It is of use to attend to the size in certain operations, particularly in bronchotomy, where we must generally cut through this gland; and, if this is done, the blood getting into the trachea, may raise a convulsive cough, which is attended with

real danger. Now, considering that operation, we may reflect on the ways of gaining advantage in certain cases of inflammation, and of avoiding the danger of blood falling into the lungs.

CLXIX.

Higher than this, a considerable branch of the lingual passes above the corner of the os hyoides, which, joined to its fellow, conveys a very large portion of blood. It is of use to judge of its situation in chirurgical operations, where tumours press in here, and we do not readily know its course by the finger, because it is supported chiefly by flesh, so that we scarcely distinguish its pulsation.

CLXX.

The next artery we call facial, supplying the inferior maxillary, and sublingual gland. The branches are set off at right angles, as those of the temporal artery, that supplies the temporal glands. So these are not more particularly fitted to receive the very active mercury than the others; and the effect of the artery in throwing out the mercury, is not to be ascribed to its passing off at a right angle, but to the structure of the ultimate branches, or of the gland, and the greater sensibility of the part.

CLXXI.

Going still higher, we find the facial artery passing over the lower jaw, about an inch from its angle, so called arteria angularis; and here we

can distinguish the pulsation, and can open it on certain occasions. In some operations we allow the parts to bleed freely; and it may be of advantage to empty all the vessels very fully; but in many other cases we wish to stop the bleeding, as in the operation for the hare lip, in the case of wounds, &c. And surgeons generally use pressure upon the extremity of the bleeding artery, or take it up with the needle. But applying two fingers upon the root of the facial artery, will assist very considerably; not but that the blood will be poured in in small quantity from the neighbouring branches; but if the principal source is interrupted, that will be found to cease.

CLXXII.

Pursuing the facial artery higher on the face, we find it supplying the small glands of the lips; and the serpentine turn it takes serves a double purpose, allowing an extension of the mouth, the artery coming nearer to the straight line; but the turns are greater than what is necessary for that purpose; and considering the situation of the vessels within the muscles, we may conceive that, from the situation and course, the saliva is better prepared, and the secretion increased by the motion as well as the exertion. At the top of the face we find the artery communicating with the ocular and frontal ones, or communications between the internal and external arte-

ries. Hence the room for Dr. Blain's proposal to open the frontal artery in the diseases of the head; but this operation is to be avoided particularly, from the artery being turned over a bone, so that it is impossible to relax it.

CLXXIII.

Following the artery still higher, we find the occipital one sent backwards. From the root of the temporal artery, the trunk of the carotids is turned inwards, and then it gets the name of the internal maxillary, splitting into a number of very great branches, supplying the muscles, the substance of the jaws, the roof of the mouth; and there is a branch going into the dura mater, and to the artery terminating in the sides of the nose, which is a continuation of the external carotid. Though these several branches never fall in the way of a surgeon, yet it is of use to know from what source each organ receives its blood; and the knowledge of their connections and vicinity may be of advantage in certain dangerous diseases, to lessen this force very considerably. Thus, if the dura mater is inflamed to a great degree, or in the case of teething in children, the force of the blood may be more lessened by opening the temporal artery in the neighbourhood, than by opening vessels that are more distant.

CLXXIV.

Corresponding to the arteries, there are two

sets of veins, viz. the internal jugular attending the carotis communis, and two external jugulars. So that even in this part of the body, where the blood returns the most readily to the heart in the erect posture, there are under our muscular organs veins running in very different directions, and one set on the outside of the muscles, free from the action of the muscles, and frequently communicating.

CLXXV.

In the external jugular veins there are also valves which are in proof that they are chiefly intended to prevent the blood from being driven backwards to the small branches.

CLXXVI.

From the free communication which the external jugulars have with the internal, it is clear that the drawing blood from them in diseases of the head, may be attended with particular benefit; and the only danger attending the opening of them, arises from certain small nerves, branches of the cervicales.

CLXXVII.

Having now traced the structure of the brain, and its circulation, there are several things that merit attention in review.

CLXXVIII.

From the appearance of the internal carotid and vertebral arteries, it is clear that a greater

than the common proportion of blood is circulated here; thus, comparing the brain and cerebellum with the arm upon which we find only the axillary artery spent, each of the internal carotids are nearly as large, and the two vertebrals joined together are larger; or there is about three times the quantity circulated within the head that passes through the arm. The quantity, however, is not so great as some suppose. If the quantity is to be judged of, nearly one-tenth, or one-twelfth of the whole is circulated upon the surface of the brain and cerebellum; but we are obliged to make a deduction from this proportion, because the force of the blood within the head is broken from a number of circumstances: the momentum is in a singular manner diminished. An allowance must be made for the blood rising contrary to its weight; and this has greater effect than is commonly imagined. In a person disposed to dropsy, it generally appears first in the feet: from the descent of the blood the exhalation is greater, as well as the absorption more difficult; and a change of posture in inflammatory cases is sometimes attended with particular advantage. Besides, when we attend to the coats of the arteries, they are very thin within the head, and even without the head; they are thinner in the extremities, and are thinner in the superior extremities than in the lower, though both are equally

affected by the action of muscles. So the momentum is considerably diminished by the ascent of the blood, and it is lessened also from the thinness of the coats, for the living power of the arteries contributes to carry on the circulation.

CLXXIX.

In addition to these circumstances, both arteries, the carotid and vertebral, make more turns in running upwards than are necessary. We do not see the use of the turn made by the internal carotid on the outside, and still less any necessity for the several turns it makes in its passage through the os petrosum. Surely we can assign no other purpose, than that nature intends to break the force of the circulation; and in other animals, where the head is depending, and the force greater upon the arteries, they are in a singular manner divided into minute branches, which are collected from a trunk a second time, whereby the force of the blood must be greatly broken, as it is from its passage from the arteries into the veins.

CLXXX.

When the arteries are pursued further, we perceive that the branches bear a great proportion to the trunks; we cannot make an exact comparison with the other arteries, but we can readily perceive that they are numerous, and the surface of the pia mater is vastly increased by the doub-

lings in the convolutions of the brain and cerebellum. But notwithstanding these several circumstances that diminish the force of the blood, we are by no means to conceive that the arteries of the brain want pulsation, and that the blood moves in them nearly in the same manner as it moves through innumerable tubes. The reasons given for this are by no means conclusive, as that the carotid artery passes through a hole in the cranium, and has its sides glued to the hole. The coats have, indeed, no motion in the os petrosus, but it does not prevent the impulse of the heart, for the pulsation remains in an artery after it is cut in the middle, and the ends of it joined by a tube; and the pulsation of the arteries of the brain has been distinguished after the skull was removed. But it has been alleged that there is not the same motion before the skull is broken, and that it is owing to the air having access, while before this these arteries could not contract, otherwise it would form a void. Now, if it can be supposed that all the veins that let out the blood are accurately tied up, after the artery is fully stretched it cannot be emptied. But if the artery and vein run parallel, and the heart gives a stroke, this is extended, and passing upon the brain, it pushes the blood down to the heart; and now the coats contracting, push the blood forwards into the brain. So the blood moves in

the same manner in the thinner part of the head as in the rest of the body, by the alternate dilatation and contraction of the arteries.

CLXXXI.

It is also to be recollected, that the obstruction in any particular part is guarded against by the unusual joining and anastomosis of the principal trunks; so that a circulation is formed round the sella turcica; and therefore, though from accident, or disease, or perhaps of motion of the head, &c. any one of the four principal arteries is stopped, the blood can pass to every minute termination in the head; and in proof of which, the common carotis may be tied, and yet the ordinary functions performed. So, upon the whole, we find a more than common quantity of blood furnished to the origin of the nerves, and that this is circulated in a very curious manner; it passes in the usual way into the beginning of the veins accompanying the smaller arteries, but these terminate in sinuses, which receive a covering from the dura mater, the use of which is very considerable, and they are so formed and disposed, that the brain cannot very much disturb the motion, as they only run where the dura mater is drawn out, supported, and made tense; nor can the sinuses swell out much, so as to disturb the functions of the brain, from their being so glued to the bones. When we consider their

shape accurately, we find it somewhat like three portions of a circle joined together. So we see one material use of the sinuses. But there is another, by the adding the dura mater to the veins, a greater thickness is given to them; and, by the veins passing into them in an oblique manner, the same effect is produced as if they had been provided with valves at their openings. Hence, when the sinuses are injected, it is seldom we succeed in filling the small veins of the brain: for there is an oblique entrance into them like that into the biliary or urinary ducts, which serves the purpose of valves, and this is of consequence: for the blood passes with greater difficulty, in expiration than in inspiration. Thus, when there is a stagnation of the blood on the right side of the heart; and if, at the same time, whilst violent exertions are made by the heart, the body should be bended, and the muscles of the neck in action, the blood might have been thrown back into the thin veins: but, in consequence of the oblique passage, though the blood should be thrown back with considerable force, they receive almost nothing of the impulse.

CLXXXII.

From the sinuses the blood passes into the internal jugular vein: this is a vessel of very considerable size, and is made larger in proportion to the artery. So anatomists mistake in conceiving

the sinuses great receptacles of blood, in which it undergoes great changes. The lateral sinuses are scarcely larger, compared with the carotid and vertebral arteries, than the veins are in other places. But their coats yield readily in the human body; and in animals that dive under water, we find large bags to prevent the accumulation of the blood within the head.

CLXXXIII.

There are two motions in the brain. 1st, The common pulsation, produced by the strokes of the heart. 2^d, In the unequal states of respiration there is a considerable pressure backwards; for the internal jugular has but a pair of valves, which do not accurately prevent the regurgitation of the blood, and the discharge of the smaller veins into the sinuses is for some time stopped, and hence takes place a considerable swelling of the larger branches of the veins entering into them. If a considerable portion of the skull is removed, and the membranes detached, that alternate dilatation is seen in a very remarkable degree; and we are apt to be deceived in supposing that such a motion takes place before the brain is opened; but there is no such heaving of it in ordinary, as occurs in this experiment; for, suppose a single half ounce is thrown into the brain, the whole impulse appears at the spot. However, though we allow that the brain has a pulsation of

its arteries as in other places, and that there is no great difference in the return of the venous blood, we have it not in our power to empty the vessels of the brain by letting blood, as we can empty the vessels of other parts. Thus, if a pound of blood is drawn from the arm, the vessels are emptied, the bulk of many parts of the arm are lessened, and the veins subside and become smaller. But this cannot happen in the brain, which constantly contains nearly the same quantity, absolutely the same, if we consider the large and small vessels: thus, if the large vessels receive a violent impulse, they make a strong pressure against the smaller, and squeeze out their liquors towards the heart, and the quantity contained in the brain will be at all times equal, nor can we lessen its bulk without making a void.

CLXXXIV.

From the danger arising from a stoppage of the blood within the head, it has been imagined that when persons have been killed by hanging, it must be owing to the stagnation of the blood within the head. But the blood continues to find its way into the heart, although there may be a kind of stupor and oppression from the pressure upon the vessels; for, upon opening the trachea arteria of a dog, it was kept hanging three quarters of an hour without being killed; but, upon putting the rope under the hole, it was found irrecoverably

dead after seven minutes; so that the death is chiefly owing to the stoppage of the respiration. And the only circumstance for distinguishing whether a person has been hanged before death, is, that if he is killed by hanging there is a purpleish ring about the neck, which is not produced by hanging a dead body upon a rope.

CLXXXV.

In the spinal marrow the circulation is carried on in the same equable manner as in the head, the quantity of blood is proportionally great, there are every where anastomoses of the vessels, and the same means are taken to break the force of the blood in them.

CLXXXVI.

Eye.

After the demonstration of the brain, and its circulation now prosecuted, we shall view its expansion in one important organ, and the particular structure of the latter, or the eye. The situation of this organ was formerly pointed out in the Osteology, and the different parts of the orbits or bony cavity demonstrated. They are lined by the continuation of the dura mater, which becomes connected with the periorbitum of the face.

CLXXXVII.

Eye Brows.

The first part to be here noticed is the eye-

brows, are the arch of hairs on the superciliary ridges of the frontal bone. Their position is oblique, with their roots to the nose, and their situation is elevated by a quantity of cellular substance. They are raised by the surrounding muscles. In their use, besides ornament, they form a shade and defence to the eye, and also assist in expressing the passions.

CLXXXVIII.

Eye Lids.

The second part to be examined is the eye lids, which are a doubling of the skin, inverted at the edge of the lid, and then laid over the fore part of the ball, so that, though common teguments, from the edge of the eye lid they become a great deal thinner, but the same general structure remains; and the vessels shining through, communicate their color. Hence we find, that where an inflammation attacks the eye, the loose skin within the eye lid swells out, sometimes, almost to cover the cornea. In the doubling of the eye lid there is a firm substance, the shape of which is seen on turning out the eye lid; it is intended to prevent the eye lid from wrinkling, to stretch it properly, and make it take the figure of the ball. This is called the ciliary cartilage, and is largest in the upper eye lid, which chiefly possesses motion. Immediately within the hairs upon the eye lid, which are longer

in those of the upper than under lid, is perceived a vast number of small openings that are just visible to the naked eye. They are the mouths of ducts which are situated upon the cartilage below the inner skin; their length is nearly equal to the breadth of the cartilage; they run in a serpentine direction, and the matter they contain appears yellowish when we look at the ducts lying upon the cartilage, but upon squeezing the ducts we find it whiter. These ducts serve to prevent the injury that would arise from the meeting of our eye lids, by lessening the friction. They are very often the subject of disease, where the eyes are tender; and we are obliged to supply the want of this matter. Hence the use of the opthalmic ointments.

CLXXXIX.

Lacrymal Gland.

The next part that comes into review is the lacrymal gland, situated in a hollow, at the upper and outer part of the eye, behind the outer end of the superciliary frontal ridge. It is an oblong yellowish gland, with one end pointed to the nose, and the other to the angle of the eye. A chain of smaller glands is also conspicuous in the same situation, connected with it; the excretory ducts are numerous, but from their minuteness difficultly traced.

DEMONSTRATION

CXC.

Puncta Lacrymalia.

From the gland we are led to the puncta lacrymalia, two small orifices in the lids, at the inner angle of the eye, one above and another below, which hold the direction of the edge of the lids, and terminate in the lacrymal sac.

CXCI.

Caruncula Lacrymalis.

They are kept separate by the caruncula lacrymalis, a small sebaceous gland, which is situated beside them, and for preserving the functions of which it is intended. Between this part and the ball of the eye lies also the valvula semilunaris, or conjunctive crescent, with its horns directed to the puncta, in order to assist the course of the tears in passing into them. In other animals it is large, and termed the membrana nictitans.

CXCII.

With this previous structure we are brought to the ball of the eye. In attending to its general form, we observe that it is composed chiefly of coats and humours, with a nervous and vascular structure.

CXCIII.

Ball of the Eye.

The fore part of the eye is rounder than the rest, or the cornea is a portion of a smaller

circle above that, formed by the tunica sclerotis, which makes a portion of a larger circle, and the optic nerve enters the eye towards one side, nearest the inner side. The lens is flatter upon the fore than the back part, and the ciliary processes are connected to the edge of the chrystalline lens.

CXCIV.

It is not sufficient that the bottom of our eye be made more sensible than the rest of its body in order to perceive the impressions of light, but it is also necessary that the light be collected, as the rays of the sun are collected with a burning glass, by which means the rays make a sharper stroke upon the retina. The humours of the eye, three in number, the aqueous, chrystalline, and vitreous, are perfectly fit for defending the sensible bottom, and for collecting the rays. By their pellucidity they allow them to pass through, by their softness they defend the parts, and by their shape they collect the rays, which form a picture of the object at the bottom of the eye.

CXC.V.

HUMOURS OF THE EYE.

Chrystalline Lens.

Of the humours, the chrystalline lens, the middle one is the principal, for with it, when out of the body, a picture can be formed as with a burning glass; so that it is calculated to collect

the rays upon the bottom of the eye, and it can do this independent of assistance from the other parts, though these co-operate. In its structure, the lens is a firm substance, included in a capsule, and which gradually grows softer towards the edges. This has led to the opinion, that a fluid is interposed between the capsule and the lens. But in a recent subject, there is only a solid; and the reason of the softness is, that in all substances the rays are collected in an unequal manner, the edges drawing them to a point sooner than the middle. Hence there is no perfect focus made by art; but here, in consequence of the softness, the light is less gathered at the edge, so that all the rays unite at the bottom of the eye.

CXCVI.

There are vessels of considerable size that are seen upon the capsule in children, which afterwards exclude the red globules, but continue to circulate the other parts of the blood. This structure serves to prevent the tender eyes of children from being injured by the light; and there is a want of clearness in their vision. Hence the capsule is provided with vessels, so that in certain cases that membrane may be thickened by inflammation, and be a cause of opacity. Hence, also, although in the cataract, the opacity is chiefly seated in the body of the lens, it may be confined to the capsule; for, after the body of the lens has been

extracted, it sometimes becomes opaque from the wound, and the admission of the air, becoming thicker and darker.

CXC VII.

Vitreous Humour.

The vitreous humour is placed between the lens and bottom of the eye. It appears like the glare of an egg, but we have reason to believe that it is confined in a capsule, though that is not so evident. It has been considered as splitting on the fore part into two divisions, when, in reality, it is difficult to show from dissection its existence; only the surface remains for a considerable time smooth, and we see vessels running through the middle of the vitreous humour, and we can scarcely suppose that they want a membrane to support them. Its principal use is to support the lens at the proper distance from the bottom of the eye, as on a cushion; and by its being thinner than the lens, it also assists in collecting the rays; for if it had not been interposed, the picture would have formed behind the retina.

CXC VIII.

Aqueous Humour.

The aqueous humour is placed between the lens and cornea, in which the iris is placed, so that it is partly lodged on the one side, and partly on the other side of the iris, possessing what are called the anterior and posterior chambers;

the anterior the larger. We are uncertain whence it is derived, whether from the cornea or iris; but we suspect that it is from the latter, as the vessels upon the iris seem better fitted for providing this humour, which is regenerated in the space of 24 hours; and we have seen an injection with turpentine rising from the iris through the aqueous humour, probably imitating the natural secretion. The aqueous humour allows the motion of the curtain, the iris, to regulate the light passing through the eye. Besides, the chrysalis is much better removed from danger, as from blows, &c. a slight rub might have disordered the lens, its vessels, and capsule; and there is reason to imagine that it helps to keep the cornea transparent, for it is naturally interposed between the layers, and passes through these; and after death the eye loses its shape, this humour exuding through the cornea.

CXCIX.

Coats of the Eye.

From the humours, we come to the containing parts, the several coats of the eye, beginning with the innermost, the retina, which is the continuation of the optic nerve, and takes its rise from the thalami nervorum opticorum, from a certain tubercle forming the bottom of the lateral ventricles, and the sides of the third ventricle. Hence we understand why in the internal hydrocephalus the

eye comes to be affected: there the thalami are squeezed on two sides, above by the water in the lateral ventricles, and within by that in the third, the ventricles all communicating. So the affection of the eye points out the collection within the head.

CC.

When these nerves are traced from the thalami, we find that they are united. It is conceived that this union is made by a cellular substance, but we can in this way give no rational account of the union, and there appears a real intermixture or decussation of fibres, or that the right optic nerve is formed from both the thalami nearly equally; and the advantage of this is apparent, for it is better that the half of the sensibility of both should be preserved, than that the sensibility of one should be altogether lost. Many advantages are derived from two eyes; and from their uniform motion, distances are better judged of, and accidents better guarded against; and a particular advantage arises from the mixture of the optic nerves where they adhere.

CCI.

On following the nerve into the eye, it is crooked a little between the foramen opticum and ball of the eye, to allow the free motion by the recti muscles; it then enters, though not directly, opposite to the pupil, but at the inner side. Now,

what reason do we assign for this? An experiment shews the use of it in the clearest manner. If the picture is brought to fall upon the entrance of the optic nerve, you lose the object altogether. Thus, if we shut one eye, and look at a piece of chalk before us, and see it from the image falling on the outside, turning our eye so far, we lose it: this we might suppose owing to the obliquity; but following it a little further, we see it again: and, on making the experiment with accuracy, we find that we lose an object whose diameter is equal to one-ninth of the distance; so, nine feet distant from the eye, you will lose a circle one foot in diameter.

CCII.

It is material to attend to this, because many have imagined the inability to be owing to the small artery entering with the nerve; but we find, on making a calculation, that the whole medullary substance, or entrance of the nerve, is insensible, the nerve not being spread into parts fine enough to receive the impression; as when a nerve is spread upon the tongue or nose, the nerve is not fitted to receive the impression. The nerve enters towards the inner side, and we find, from attending to the angle the eye forms with the object, that the entrance is somewhat more than $\frac{1}{2}$ of an inch removed from the centre of the eye: thus, suppose you pass a needle through the eye,

and measure from the bottom somewhat more than $\frac{1}{2}$ of an inch, that is the place where the optic nerve enters. The reason of its entering at the inner side is evident; if the nerve had entered at the outer side, pictures of a single object would have formed at the same instant in both eyes, but the rays fall upon the outer side of the left, when on the inner side of the right.

CCIII.

Retina.

We find the nerve forming the retina, which is the expansion of the medullary substance. The name is improper, for it is an uniform membrane, and no net-work, which would have lost parts of the objects, for it expresses nothing more than a web uniformly extended upon the inner side, covering the vitreous humour. It has been described as going to the edge of the chrystalline lens, and some of the fibres passing over it. But it is unnecessary that they should extend over the lens; it would have disturbed the vision upon the posterior part, and we find that it terminates like the edge of a tea-cup behind the lens. There may be some fibre, perhaps, going forwards to the chrystalline lens; it may receive a nervous fibre from the retina, though it seems rather to receive it along with the vessels.

CCIV.

Choroid Coat.

It is covered by the choroid coat, the inner side of which is incrusted with a black point, forming the appearance of a membrane. That serves the very opposite purpose of quick-silver on the back of a mirror, it prevents the reflection of the light, or its being thrown back again so as to make a second impression, it suffocates the rays. From the experiment, that the entrance of the optic nerve is insensible, other anatomists concluded that this coat was the organ on which the picture made its impression. But we observe that blindness is occasioned by a disease of the thalami nervi optici, by pressure upon them, or what is the use of the retina, why so fine a web, if it is only a sort of cover to the choroid? Next, pursuing the choroid as a web and firm substance, we find it makes a turn, and it is connected to the chrystalline lens by what has been named the ciliary processes, which are only the terminations of this coat contracted into a narrower circle, just as the sleeve of a shirt is folded into a number of doublings at the wrist. Hence there is no space for light passing between the ciliary processes and the lens; if there was, the aqueous humour would mix with the vitreous, but it separates these, and serves to support the chrystalline lens in its place, which rests upon the vitreous humour as upon a cushion,

and is supported at the edges by the continuation of the choroid coat. This opinion has led to very wrong ideas of the part affected in diseases of the eye, all the rays of light that strike the retina have before that passed through the chrystalline lens. Thus, if a cataract is uncommonly opaque from the want of sensibility to light, we are not immediately to infer that the retina is in a diseased state, unless we find other circumstances that may lead us to suspect this.

CCV.

Iris.

We next consider the iris, described as the continuation of the choroid coat, one part of which is supposed to form the ciliary processes, and the other the iris; but other anatomists observe, that the iris is totally distinct from the choroid, and is merely connected to it by the ciliary circle, or they are joined by cellular substance, which also connects the iris to the sclerotic coat, so that the watery humour is prevented by the ciliary circle from entering between the sclerotic coat and the choroid; and thus we observe a white opaque substance, forming a ciliary ligament at the root of the iris. The iris has an aperture in the middle, which we call the pupil of the eye. When we follow the vessels of the iris in an injected preparation, these are chiefly derived from the choroid coat, and we find nerves entering in considerable number. Near the root

of the iris there is a circular artery, or at its root all the vessels communicate; we then trace them to the edge of the iris, and follow them all this course with the naked eye, and yet many anatomists imagine that no red blood enters the iris, and that its vessels convey colourless humours only; but besides this evidence, from the appearance of the vessels, from accidents, we know that, the iris circulates a considerable quantity of red blood, which is seen mixed with the aqueous humour. In such cases, a cloud or film appears within the cornea, and upon holding the head steady, the cloud goes off. That proceeds from the red blood being mixed with the aqueous humour. When the head is held in one position, the blood falls to the bottom of the humour, and the iris is not connected where the sclerotic coat joins the cornea, but behind the joining, so that it falls lower than the edge of the cornea, and goes entirely out of sight: and, in attempting to extract the chrySTALLINE lens, if the iris is wounded, red blood comes from it, and there is a great redness and inflammation of the part. Hence it is certain that these vessels convey the red blood in life, but the red colour of the vessels is concealed from us by that paint or colour which is laid over them, and the aqueous humour is probably secreted from the vessels of the iris.

CCVI.

The principal use of that coat is to exclude a superfluous quantity of light, and to allow as much as is useful to reach the retina; hence, when the eye is turned towards the light, the pupil is smaller; and when it is turned from the light, it becomes larger, adapting itself to the quantity of light. But there is something more than that happens; it is not merely affected by the general quantity of light, but it is contracted or widened wherever objects become indistinct, by being placed too near the eye; thus it contracts if the object is indistinct; and turning the eye downwards, the pupil gets a certain diameter; but, if the point of a small pin is brought near the eye, the iris, though not now solicited by more light, contracts a little more than before to see it distinctly. Thus if there is a small hole made in a bit of paper, and there is brought to it a small printed book which appears confused, when viewed through the hole it appears more distinct, and this experiment enables us more readily to receive the fact, that we distinguish the motion of the iris in viewing near objects.

CCVII.

This circumstance respecting the pupil is of the utmost consequence to attend to in judging of diseases. When the eye is insensible to the light, there is a very small degree of motion in the iris;

and it is the same whether the eye be less sensible to receive the impression, as in the gutta serena; or is less sensibly impressed by the light being intercepted, as in the cataract: in both cases the pupil becomes larger.

CCVIII.

Some have supposed that the motion of the eye was owing to the light striking the iris, and affecting it; but it evidently depends upon the manner in which the retina is affected; for the pupil loses its motion nearly as much in the cataract as in the gutta serena, or the two eyes sympathize: suppose one eye is diseased, and that the pupil is little affected by imitating it; yet, upon opening the sound eye, the irritation upon the one affects the pupil of the other, so the motion depends upon the affection of the retina.

CCIX.

Besides the circumstance of the eye adapting itself to the confusion of objects, shews an instructive power, which is more extensive than we are commonly aware of. We not merely contract the pupil, and allow it to relax itself by its natural tone, but we possess a muscular structure; not one that can be shewn by dissection; indeed, we cannot shew a sphincter for contraction, or fibres for dilatation, but we possess the power of contracting or dilating the iris beyond its tone. The contraction is known from the common effect of light;

but wherever the retina is uncommonly insensible, by disease, the pupil is widened far beyond its natural tone; and, in persons dying, the pupil is seen much larger than it was five minutes after death, which brings it nearly to the same size as when the eye is not turned to a very clear light, nor in too great obscurity. But in the hydrocephalus and amaurosis it is greatly dilated. When the patient is aroused by giving him hartshorn drops, &c. the pupils are greatly dilated; and when the stimulus is made by light, upon bringing the candle near the eye, the pupil opens so wide that the colour of the iris is scarcely to be distinguished. It has been accounted for from mechanical irritation; but when the patient is roused, there is an effort made to see; the quantity of light is not sufficient to make an impression; therefore, by an instinct of nature, there is an effort to enlarge the pupil; and immediately after death it contracts to a much smaller size than it appears in these diseases.

CCX.

Cornea and Sclerotic.

It remains to consider the external coats, the cornea and sclerotic. Whilst the cornea serves the same purpose, by its pellucidity it transmits, and by its roundness it collects, the light; for the light is in a great measure collected before it reaches the lens, that it may be accurately regulated by a

smaller motion; the light is brought into a very small pencil of rays, so that the iris, by a very small motion, exactly regulates what is necessary. The eye is supported in its place by the tunica adnata vel conjunctiva, which is produced from the eye lids doubled; and we trace it over the eye, even making a part of the outer layer of the cornea, though it is not separable by dissection, but it is laid more loosely over the sclerotic coat, and many vessels run here, so it is subject to inflammation, which often extends over the whole eye, and the whole very sensible substance of the eye is covered with vessels; and we often find produced upon it. Where the vessels are very deep, there may be a dilation of the natural vessels; but in 99 cases of 100 they are a new growth, beginning in the sclerotic coat, and gradually extending over the cornea, as in the case of a loss of substance or wound; and we may trace them with the eye over the coat, and these arteries meet again with veins to return the blood.

CCXL

The tears next are conducted to the puncta lachrymalia, and pass down into the nose, where they are poured out under the inferior os spongiosum. But, by what power are they taken up, and thus conveyed to the nose?

CCXII.

The puncta have open mouths, which are supported by a ring of hard cartilaginous matter, and the ducts gradually enlarge, and end in the lacrymal one. It is evident that the tears are not pushed into the puncta by force, for pressure makes them run over the cheek; so they must be sucked in by that power inherent in small capillary tubes; and they are thus conveyed a certain way. We shall suppose that this power is sufficient to fill the ducts altogether; that the whole sac and ducts are filled by attraction, which is, perhaps, not true. We cannot suppose the motion continued; it does not empty these again; for, supposing the supply cut off, the duct remains full, because the same power that draws the tears into the ducts, if no more tears are added, prevents the emptying. There is an attraction that would suspend the tears within the ducts; but, if more fluid is added, it comes to represent the common syphon in its operation, and there must be a muscular power in the holes to push on the liquor.

CCXIII.

From this view of the general structure of the eye, it appears that its first coat, or tunica adnata, connects the eye by its thin pellucid membrane to the orbit, and protects it from the irritation of extraneous bodies. Its next coat, or the cornea, hard and dense, forms its anterior covering, is

more convex than the rest of the ball, and is joined to the sclerotica as the segment of a small sphere to that of a larger one, containing the aqueous humour within its membrane. The convex iris composes a transverse septum, floating in the aqueous humour between the cornea and sclerotica, with a middle perforation for the pupil. The iris, on its back part, displays a dark coloured pigment, termed the uvea; on removal of which, its structure consists of two sets of fibres; one radiated, of various colours, and giving the particular colour to the eye; the other circular, and forming the sphincter muscle of the pupil, which regulates its motions as influenced by the impression of light made upon the retina. The sclerotic, the next coat, is firmly fixed to the edge of the cornea, and is the most extended and strongest membrane of the eye, with fibres running in every direction. Its inner surface is in contact with the choroid coat, the connection being formed by vessels, nerves, and cellular substance. This thin coat, entirely vascular, is of a dusky brown colour, having on its inside a dark coloured mucus or pigment, which gradually disappears, or becomes lighter in its course towards the optic nerve. The connection of this coat at its fore part, and the former, and also of the iris, is made by condensed cellular substance in the form of a shining cord, termed the ciliary ligament or circle, opposite to

which is a black radiated ring, consisting of ciliary plicæ, or processes, and striæ, named the corpus ciliare, and composed of the continuation of the vessels of the choroid coat. The optic nerve in its course through the orbit, is covered by its membranes from the brain, but after its ingress through the sclerotic coat, it expands to form the retina. The retina is a tender pulpy substance, semi-transparent, and of a light grey colour, varying in its equality and thickness, in different parts advancing between the choroid coat and capsule of the vitreous humour to the fore part of the eye, and terminating upon the anterior edge of the chrystalline lens.

CCXIV.

Of the humours, the aqueous is lodged in two chambers or cavities. The anterior is situated between the cornea and iris, and the posterior between the iris and chrystalline lens. The chrystalline lens placed behind the aqueous humour, is opposite to the pupil, and lodged in a depression on the fore part of the vitreous humour. It resembles, as already noticed, a burning glass. It varies in figure and colour at different periods of life, is composed of concentric lamellæ placed over each other, and the firmness of its substance increases as it advances to the centre. It is surrounded by its proper capsule, or covering, which is so elastic that its puncture readily allows the

disengagement of the lens. The vitreous humour fills the space from the chrystalline lens to the entrance of the optic nerve at the bottom of the orbit, and is concave before and convex behind. Its space is equal to $\frac{2}{3}$ of the eye. Its structure consists of delicate cells communicating with each other, including the liquor; and on its surface there is a transparent smooth coat, termed vitrea. To the vitreous humour the lens is fixed by an external circular lamina, inserted into the fore part of its capsule, termed the zonula ciliaris.

CCXV.

While the aqueous humour is on evacuation easily renewed, and while the chrystalline lens can be also displaced, and vision preserved, the loss of the vitreous humour is inseparable from the functions of the eye, and cannot at any time be renewed.

CCXVI.

To conclude our demonstration of the eye, its circulation still remains. This it derives from the carotids. The lids are supplied by the frontal, fascial, and temporal arteries; and these arteries again communicate with those within the orbit.

CCXVII.

The ocular, or ophthalmic artery, passes through the optic hole along with the nerve; and though in size no bigger than a crow quill, from it a considerable number of arteries arise, for it supplies

not only the eye itself, but all the appendages of the organ. Thus, it first sends a branch which takes its course outwards and inwards along the eye to supply the lacrymal gland, where it is exhausted. It next gives circulation to the organ itself, by means of a branch perforating the optic nerve, and distributed upon it; and also by means of the ciliary arteries, which go inwards to the fore part of the eye, where the ciliary circle lies. It then supplies the muscles by means of an artery proceeding from the same situation as the ciliary. Two arteries then pass from the socket through the ethmoid bone to the nose; and, lastly, the branches which are spread on the forehead and nose proceed directly from the ophthalmic trunk.

CCXVIII.

With these arteries, as elsewhere, the veins correspond; and they, at the same time, communicate partly with each other, and pass partly to the external jugular vein and branches situated about the fore part of the orbit, and partly to the internal jugular vein of the cavernous sinus.

CCXIX.

That the eye may properly execute its functions, it is necessary that the rays of light be fully collected on the retina, and meet in one point or focus; and to effect this, a due convexity of the cornea and lens must always take place. When

too great prominence prevails, the rays become too soon collected, and vision is indistinct from this cause, or people are short-sighted. Where an excess of flatness is conspicuous, the reverse of this ensues, and only an indistinct focus is formed, as in the case of age. The motions of the iris and the muscles of the eye, regulating the presence of light, and determining by their action the length of its axis, enable the organ to accommodate itself to the distance of objects.

CCXX.

Chemical Analysis of the Cranial Secretion.

The thin vapor or fluid contained between the dura and pia mater, and also in the ventricles of the brain, seem in its constituent principles to be composed of carbonated hydrogen gas and water.

Vascular Preparation of the Head.

In order to shew the circulation of the head, the latter should be separated from the body about the 6th or 7th vertebra. A pipe is then to be fixed in each carotid artery, or they may be both injected at the same time, and the injection should be red. The jugular veins are also to be filled in the same manner, with a yellow injection, the cervical vessels being previously secured by ligature, to prevent its escape.

When the injection is finished, a part of the jaw bone must be removed to shew the course of the internal carotids, and it should be behind the last molar teeth. On one side, the muscles should be dissected away between the cervical vertebrae to shew the course of the

vessels; and, on the other side, they should be only cleared of fat and cellular substance.

The external view being thus secured, sections are to be made of the summit of the cranium to shew the internal parts, and that in various ways, according to the purpose intended by the anatomist. A saw must be used to accomplish this, and the membranes, on removal of the bone, are to be divided by a knife or scissars.

Chemical Analysis of the Eye.

The quantity of the aqueous humour is 4 or 5 grains, but it varies in different cases; by smell in the fœtus, in age, and in dying; but it is more quickly repaired when destroyed, than any other fluid in the body. Its principles consist of water with animal hydrogen gas, and sometimes a small proportion of soda, and muriat of soda.

The chrystalline lens, in gravity, is equal to 4 grains. By its maceration in spirit of wine, or vinegar, it separates laminae like the leaves of a book, separable from each other by a scalpel. In acids it is rendered opaque, and condensed by congelation.

The vitreous humour is heavier than common water, and bears a proportion to more than two thirds of the weight of the eye. It resembles a singular species of tremulous jelly. It is rendered turbid by most other salts but the acetous acid.

The pigment, or coloured mucus of the iris, differs in its two surfaces. In the posterior surface it is always black, but in the anterior it is various. In cold countries it is bluish, or of a pale ash colour. In warm

regions it is of a dark chesnut or black hue, and various shades are sometimes observable in different parts of the same eye.

The constituent principle of this pigment is animal mucus, mixt with a peculiar colouring matter.

The pigment of the choroid membrane is of the same nature, and answers the same purpose.

The tears, or lacrymal secretion, is an aqueous liquor, saltish to the taste, and in quantity only moistening the eye, but capable of being increased to great extent from any irritation or stimulus applied to the organ, so as to overflow the eye, and pass down by the cheek.

The constituent principles of this secretion are ;

1. Water, in great proportion.
2. A peculiar kind of mucilage.
3. Muriat of soda, phosphate of lime and of soda, and soda in a caustic state.

Hence their inspissation by the absorption of oxygen from the atmosphere.

The secretion of the eyelids is an oleaginous mucus, not soluble in water, and inspissated by the oxygen of the atmosphere. When mixed with the tears, it forms a kind of glue, cementing the lids together.

The mucus of the caruncula lacrymalis and lacrymal sac, is of the same nature.

CCXXI.

After having seen the brain, and its expansions on the eye, we are next to pursue its different prolongations as they proceed from the cranium, and constitute the nerves.

CCXXII.

The first pair is called the olfactory; it passes through the cribriform bone, and is divided into a number of small branches without receiving any firm covering from the dura mater; and the ethmoid bone, within the nose, is composed of a number of cells, that the nerve may be divided as much as possible, because there must be a certain division of parts before the sensation can take place, as in the eye, where the nerve is insensible at its entrance.

CCXXIII.

Next, we see the optic nerve united; the nature of the union has been already explained, that the threads actually decussate one another. This connexion has been supposed to account for the uniform motion of the eyes; but we need only to observe that the optic nerve, does not terminate on the organs for the motion of the eyes, it is merely a nerve for sensation. When we proceed to trace the optic nerve, we see the medullary substance spread out into an uniform coat, and there is no reason to imagine any kind of motion has been inferred.

CCXXIV.

In this soft and fine substance called the retina, the nerve must be spread out, and it terminates in

exceeding minute parts. From the smallness of the picture we would infer, that the diameter of one of the threads does not exceed the twenty thousandth part of an inch, supposing that the picture occupies but a single thread; but the probability is, that a number of the threads are affected by every picture at the same time; we see, therefore, that there may be numerous nerves distributed to parts, though we are not able to trace them.

CCXXV.

The third pair of nerves is called oculi motor, supplying many of the muscles of the eye; we find likewise produced from that nerve small threads, which join to supply the iris.

CCXXVI.

The next pair, the fourth, is singular in every circumstance. In its origin, which is very distinct from the testes, and from the origin of the third pair, which is a nerve of the brain, and the other of the cerebellum, and it terminates in a single muscle, the trochlearis. Some think that it is the chief instrument of expressing the passions of the eye, so it receives a thread undivided; but observe only the distribution of the third pair. We find a muscle co-operating supplied by a common root, and the third supplies the attollens and depressens oculi, which are antagonists, so we would

leave this as a circumstance that we cannot explain. Where nature is uniform, the distribution is intended for some wise purpose; but in the present instance that lies concealed.

CCXXVII.

The fifth is the largest nerve of the cranium, and is soon spread out into a considerable branch, which is separated into three divisions. The first and second send some branches into the nose, and other branches supply muscles, so it serves both for motion and likewise for sensation; and the third branch serves not only for sensation on the point of the tongue, but taking its course towards that point, it supplies the muscles of that organ, and branches are sent to the maxillary and sublingual glands, to regulate the secretion of the saliva. Now, though certain nerves, as the olfactory and ophthalmic, have a greater whiteness than we observe in the other nerves; yet, in the fifth pair, the branches supplying the senses have the same colour as those destined for motion, and hence we conclude that all its offices are performed by the same medium. Those nerves intended for more distant parts are exposed to injury, and receive, perhaps, an addition of the nervous influence from the coats that cover the proper nerves.

CCXXVIII.

* When we now look back to the origin of the five first pairs, we find that the first, second, and third pairs are nerves of the brain, whereas the fourth and fifth are almost entirely derived from the cerebellum, yet similar offices are done by both. The first and second are organs of sense, the third of motion, the fourth of motion, the fifth of sense, motion, and for assisting in regulating the secretions; so that there is no reason for imagining that the offices of the brain and cerebellum are so very different as some physiologists have pretended.

CCXXIX.

The fifth joins the third, forming a small ganglion. The only remark to be made upon it is, that we see ganglions in these parts which serve the most material purposes.

CCXXX.

The sixth pair is spent upon the abductor muscle, for a reason we do not pretend to understand, why the third might not have furnished the abductor as well as the other recti.

CCXXXI.

In its course, we perceive the connection made by two distinct threads which form the beginning of the intercostals; for it is absurd the dispute about the course of these, whether it is upwards

or downwards, whether they come from or go to this nerve. If they come from the intercostals, we have no origin to that nerve; besides, we constantly observe that the sixth pair becomes smaller betwixt this place and the eye; so these, with the branches from the fifth pair, are the highest origins of the intercostal or sympathetic nerves.

CCXXXII.

The seventh is divided into two portions, one of which is without a covering, because it is in no danger of being tore, and is called the *portio mollis* of the auditory nerve; but the other branch, running outwards, receives the covering from the *dura mater*, and is called the *portio dura*. And as we have found more than one nerve supplying material organs, the *portio dura* is joined by a branch from the second of the fifth, and we find a nerve connecting it to the second and fifth; and there is no doubt with regard to the *chordæ tympani*, that they are from the *portio dura*; and that the point of the tongue is supplied by the fifth in two places joined to the seventh; so that care is taken that we may not want the sensation of the tongue.

CCXXXIII.

Pursuing the *portio dura*, we find a very great number of branches spent upon the face. We may venture to allege, that the number is greater

here, in proportion, than what is spent upon the other muscles, because the muscles of the face perform a double office; they not only serve for the motion of the lips, but for expressing our passions; and our nerves are large in proportion to the exercise of the motions of the organ in which they terminate.

CCXXXIV.

The *portio dura* is joined to other nerves; but the branches, instead of forming continued canals, pass over each other; and where a muscle is supplied, it receives a thread from each of the nerves: so we find a greater care taken to prevent these from losing their power than most of the other muscles, because of the importance of their office. Thus, if we can open and shut the mouth with half the natural force, it is better than that we can open and not shut it.

CCXXXV.

The next pair going very far downwards, is named *par vagum*. It supplies the larynx; and as the function of that organ is material to life, so every precaution is taken to guard against accidents; hence there is a superior *linguæ*, and a recurrent sent back in a very particular manner. And, in endeavouring to determine the final cause, it is found that the voice is not lost by cutting one of the nerves, though the recurrent. The

Several tones, indeed, and the general strength of the voice is diminished, but it is by no means lost.

CCXXXVI.

The ninth pair, like the fifth, supplies first the muscles, and then the organs of sense, and likewise the secretions; for from the surface of the tongue there is a considerable secretion of mucus.

CCXXXVII.

Nose.

In this distribution of the nerves, we find the first pair distributed on the nose.

This organ consists of two parts, a hard and soft one. The hard part, or bony structure, was formerly examined; and, at its under and fore part it consists of five cartilages, of which one is situated in the middle, and the other four laterally.

The middle one supports the rest, and constitutes the septum, or division of the nostrils.

CCXXXVIII.

The lateral cartilages are placed two anteriorly, forming by their curved union the top of the nose; and two behind, which compose the alæ nasi, and between these are smaller ones of various size and figure. These cartilages are moved in different directions by the muscles formerly described, and over the whole is thrown the common tegument, which are perforated at the under and outer part by large sebaceous glands.

CCXXXIX.

The internal cavities of the nose extend upwards to the cribriform plate of the ethmoid, and to the body of the sphenoid bone. They are bounded by the middle partition, partly of bone, and partly of cartilage; and, on the outside, the spongy bones project into them, and increase the surface of the membrane.

CCXL.

The bottom of the nostrils runs straight backwards, admitting the passage of a probe into the throat, and the fore part is defended by stiff hairs which detain the mucus, and prevent the entrance of external irritation.

CCXLI.

The cavity of each nostril has been divided into three passages, a superior, middle, and inferior one. The first ascends to the upper spongy bones, the second to the junction of the superior and inferior spongy bones, and the third from the termination of the inferior ones to the bottom of the nose.

CCXLII.

These cavities are every where lined with a thick spongy membrane, which is continued likewise over all the adjacent parts, which is highly vascular and nervous, and constitutes the primary organ of smell, having its surface kept constantly moist and lubricated, with a mucous secretion from its numerous follicles.

In this cavity of the nose all the sinuses of the cranial bones terminate, and the same covering extends over them as extends over the nose, but it is thinner and less vascular. This termination of the cranial sinuses seems particularly intended to increase and modulate the voice.

CCXLIII.

In this cavity of the nose likewise terminates the lacrymal sac and incisive duct. The first was already noticed in the Osteology. It is a membranous canal, the duct of which ends in the inner and fore part of the antrum maxillare. The second is a small canal, or passage in the foramen incisivum, which is not only open in the skeleton, but in the natural state of the body, though in many subjects it is entirely shut. Its office is to convey the tears from the nose into the mouth; for the tears dropping from the lacrymal duct, when the head is in an erect posture, fall into that canal.

CCLXIV.

The circulation of the nose is supplied chiefly from the branches of the external carotids. The outer part receives certain divisions of the facial, and of the internal maxillary arteries, while the inner draws its circulation from the internal maxillary artery, and small branches of the ocular arteries. Its veins again terminate in two ways, either in the external jugulars, or by communi-

cating with the ocular veins, their circulation passes into the lateral sinuses and internal jugulars.

CCXLV.

The nerves of this organ, or of the internal part of the nose, are principally the olfactory, or 1st pair, assisted by some branches from the 1st or 2^d portions of the 5th pair, while the outer surface draws its feeling not entirely from the same source, but from the 2^d branch of the 5th, and from the portia dura of the 7th pair.

CCXLVI.

Chemical Analysis of the Nasal Secretion.

The quantity of this secretion is very various; when thin, it is pellucid; but when thick, it is otherwise, and mixt with various matters. In consistence it is viscid and ropy, adhering to all bodies. It is mixed more or less with two other excretions, an aqueous fluid from the sinuses, and the lacrymal fluid. At its first secretion it appears analogous to the tears, but it changes by its stay in the nose, absorbing probably oxygen from the air, and having the carbonic acid of the expired air saturating its uncombined soda. Of all the animal fluids, it is the least subject to putridity, and it may be kept for any length of time without producing any fœtor.

CCXLVII.

From the demonstration of the nose, we are directed naturally to that of the mouth, the osseous and muscular parts of which have been already described.

CCXLVIII.

Mouth.

We begin, therefore, with the lips and cheeks, which, besides their muscles, consist only of the external teguments and the internal covering, lined with mucous glands.

CCXLIX.

This membrane is covered with fine villi, most conspicuous on the edge of the lips, especially by a fine injection, or by macerating them till the separation of the cuticle. On entering the mouth, the gums next appear as formerly described (Vol. I. CCV.); and, on leaving them, we are next directed to the palate and tongue.

CCL.

Palate.

The palate consists of two parts, the bones already demonstrated (Vol. I. LXXXVI.) covered by the periosteum and villous membrane of the mouth, distinguished here by numerous rugæ, intended to assist the division of the food, and to increase the force of its pressure against this part in order to extend the powers of taste, and the soft parts, or velum, forming a partition between the mouth as formerly described, (Vol. I. CCCXXII., &c.) and composed of the membranes which line these parts beset with mucous glands, and its own muscular expansions which enable it to act in swallowing, as a valve, on the nose. From this part,

we also see its uvula or pap descend, a part of material use in deglutition and speech.

CCLI.

Tongue.

The tongue, the next object of our attention, is of an oval form, and divided into three parts, its base, its body, and its apex; and the composition of this organ, except its membrane and papillæ, consists entirely of muscles, already demonstrated (Vol. I. CCCXXXV. &c.). The base of the tongue is connected, as we have seen, to the os hyoides (Vol. I. CCXCVIII.) and its body terminates anteriorly in the loose moveable point. Its upper surface is divided by a middle longitudinal groove; and its inferior surface, so far as it extends backwards, is connected to the parts below by the sublingual ligament, or doubling of the skin lining the mouth. Membranous ligaments attach its sides to the lower jaw and adjacent parts.

CCLII.

The coverings of the tongue are three in number: the common teguments, kept moist by the saliva, and formed also into vaginæ for the papillæ; the corpus mucosum, thicker here than any where else, but also preserved in a moist state; and the true skin, of a bright nervous texture, from which the papillæ of the organ proceed.

CCLIII.

These papillæ are confined to the upper surface

f the tongue, and are most numerous over its apex. They are divided, from their size, into three orders. The 1st are largest, have round heads and short stems. They are placed more at its base in superficial pits, and form, as it were, an angle with its point backwards; their secretion is of a salivary nature, proceeding from a perforation in the middle of each. Besides these papillæ, numerous mucous follicles cover the surface of the tongue. At its root, also, there is a hole, which receives the mouths of several excretory vessels terminating upon it.

CCLIV

The 2^d order of papillæ is of a cylindrical form, and ends in a round extremity, being scattered over the upper surface of the tongue, at some distance from each other.

CCLV.

The 3^d order is numerous and minute, extending over the apex; and to the former and this the impression of taste is chiefly ascribed.

CCLVI.

The circulation of the palate is derived from branches of the facial, and internal maxillary artery, while its veins are directed to the external and internal jugulars.

CCLVII.

The circulation of the tongue is supplied from the external carotids, and the branches they be-

flow for this purpose are termed *linguales*, or, from their black colour under the tongue, *raninae*. In proportion to the size of the organ, its vessels are apparently large; and they have less communication with each other in the opposite sides than in other parts of the body.

CCLVIII.

The nerves of the palate arise from the 2^d portion of the 6th pair, with some twigs of the 8th.

CCLIX.

Those of the tongue are from the 5th, 8th, and 9th pairs. They are large in the same proportion as the vessels; and they have, likewise, little connection on the opposite sides.

CCLX.

To finish the demonstration of the mouth, its glands remain, which are three in number: the parotid, the submaxillary, and sublingual; all of a yellow colour, and of the conglomerate kind.

CCLXI.

The parotid is a large gland, named from its particular situation, and it occupies the space between the ear, mastoid process, and angle of the lower jaw, extending to the zygoma and masseter muscle, which it partly covers, and lying contiguous below to the submaxillary gland.

CCLXII.

From different parts it gives out small branches, which join in a large duct passing from the upper

and fore part of the gland; and the cavity of the gland is small, proportioned to the size of this duct.

CCLXIII.

In it's progress, it passes transversely over the masseter tendon, where it receives some additional ducts from smaller glands; and descending, it perforates the buccinator muscle, opposite to the 2^d or 3^d upper molaris.

CCLXIV.

The submaxillary gland, rounder and smaller than the former, lies between the angles of the lower jaw and the digastric muscles. From its upper and fore part arises a duct, thinner and longer than the former, which passing to the side of the frænum linguæ, terminates by a small papillary orifice behind the incisors.

CCLXV.

The sublingual gland, oval and flat, is also smaller and softer than the last. It is situated under the anterior portion of the tongue, with its extremities forwards and backwards. It is covered by a continuation of the lingual membrane, fixing it in its place, and it opens on the outside of the frænum by several small orifices on a line with the gums. It sometimes communicates by a branch with the submaxillary ducts.

CCLXVI.

Besides the glands described, a number of small

ones are conspicuous on the inside of the mouth, situated between its inner membrane and the muscles; and each of these perforate its cavity by a small duct.

CCLXVII.

The circulation of the salivary glands is supplied by the external carotids. The parotid derives its supply from the temporal artery, the submaxillary from the facial, and the sublingual from the lingual artery, while their veins are returned to the external jugulars.

CCLXVIII.

The origin of their nerves is traced from the 3^d part of the 5th pair, and from the portio dura of the 7th.

CCLXIX.

By these glands is the secretion of saliva made and poured out by their ducts in large quantity for the solution of the food, lubricating the parts, and assisting digestion.

CCLXX.

Chemical Analysis of the Saliva.

The secretion from the salivary glands is one of the most important to the animal economy. It is not less than to the amount of 12 lbs. in 12 hours, and it is considerably augmented either by irritation of the parts, as in mastication, or speaking, or by hunger.

The constituent principles of the saliva are;

1. Water, to the amount of $\frac{3}{4}$.

2. Albumen, dissolved in the water.

3. Compound salts, consisting of muriat of soda and phosphate of lime, as occasional concretions in the ducts shew.

Saliva possesses an antiseptic virtue, it promotes the spiritous fermentation of vegetable matter, it is dissolved by alkalis, and it gives out, during the solution, ammonia.

Anatomical Preparation of the Parotid.

This gland should be injected in its place from its numerous small branches. To do this, the skin should be raised on the side of the face from the ear to the mouth, and from the temporal muscle to the neck, and in doing it the knife should be kept close to the skin so as to avoid the gland, and the fat and cellular membrane dissected with much care from the masseter muscle to find the duct about 2 inches long, and resembling in size a crow quill. An opening is to be made into it with the point of a lancet, so as to introduce the point of the steel injecting pipe as far from the gland as possible; which, once introduced, is to be secured by a ligature with one knot. When the gland has received as much quicksilver as it can contain, the pipe is withdrawn, and the duct secured by ligature, after which it is to be carefully dissected from its place, first securing its numerous branches by a small needle and ligature before dividing them. The gland removed is to be laid in a dish, the extraneous parts about it removed, then laid in clean water for a day or two, after which it is to be spread on pasteboard and placed in the air to dry, after which it may be preserved in a glass vessel with oil of turpentine.

CCLXXI.

Having thus seen the structure of the nose, mouth, and tongue, let us examine the use of these parts, and the reasons of their structure, beginning with the sense which is exercised in the most simple manner.

CCLXXII.

Taste.

Very large arteries and nerves are observed to be sent to the tongue, which is necessary from the tongue being an organ of very considerable motion, and from exercising the sense of taste; besides which, from its surface there is a considerable secretion; for to the last purpose a great quantity of blood is essential: but a quantity of blood is likewise constantly found circulating in organs that perform a large motion, and still more in organs of sense. The reason of this, at first sight, is not so certainly evident; but there is reason to believe, that as the heart and brain act upon each other in a circle, we find ourselves at a loss to distinguish cause from effect; in like manner the arteries and nerves, in their progress, act upon each other. And there is further reason for believing that, in a manner not fully understood, the arteries tone the nerves for receiving their impressions, and conveying them distinctly. When we compare the tongue with the nose, we see this in a clear point of view.

In the membrane of the nose, there are such a great number of vessels that circulate red blood, that we should be apt to imagine that these would prevent the distinct impression of the nerves; but, on the contrary, they contribute to increase the distinctness of it; and in making experiments with medicines, how far they act by immediately influencing the nerves, this is apparent. Thus, after the circulation is interrupted in the course of the nerves, as the sciatic, though the organ is quite entire, medicines cannot influence the system through that single branch after the circulation has ceased, though they produce the most violent symptoms when applied to the corresponding nerve where the circulation is carried on; so that the arteries actuate the nerves in their progress something more than merely by giving them a certain degree of tension; and, in like manner as we find the arteries assist the nerves in their office of sense and motion, the nerves assist the arteries in performing their secretions. Hence it may be alleged, that the numerous nerves of the tongue not only are intended for motion and sense, but for regulating the secretions made from the extremities of the arteries.

CCLXXIII.

In exercising the sense of taste, we apply saline substances, which are divided upon the surface of the tongue; and, if we do not perceive the im-

pression, we press the tongue against the palate; not that the palate is the principal organ of taste; for, upon rubbing the body of the tongue against the palate, we have no distinct impression, but the effect is to make the greater impression upon the tongue: whether the several papillæ are rendered more sensible, is uncertain. The swelling of the papillæ of the tongue, upon irritating them, has been observed by some; and there is probably a filling of the vessels in order to give a greater sensibility to the part.

CCLXXIV.

The nostrils are also situated, that we may smell substances at the same time that we taste them; and they do not receive the current of the atmosphere, but the current of air ascending from the roof of the mouth. When the air enters the nose, instead of running in the most direct manner into the throat, it rises upwards to the top of the nose, to the ossa spongiosa, which are the principal part of the organ of smell; for, upon examining a variety of animals, the acuteness of smell varies with the extent of the surface of these bones; and, in a dog, they are extremely convoluted; and from thence we understand the reason of the name of turbinatum.

CCLXXV.

But is it to be imagined that the sinuses, or larger caverns that communicate with the nose,

contribute to increase the surface of the organ of smell? or is it to be said that the membrane lining the sinuses supplies the moisture to the nose, to prevent it from being dried by the current of the air? We do not see that the sinuses are necessary in order to supply a sufficient quantity of moisture; for if, in inspiring, a great deal of moisture is carried away, at the next moment, when we expire by the same passage, we not only return through the nose all that we took from it, but the addition of the vapour brought from the lungs.

CCLXXVI.

Some of the sinuses, also, have the opening at the top. If these were filled with moisture when we are some time in an erect posture, upon bringing the head forwards we should see it discharged; and the sinuses being filled with water, would counteract one of the main purposes of the sinuses, the effect they have upon the voice. And with no better reason are they supposed to extend to the organ of smell, for children smell as acutely as adults, and yet in them the sinuses are only beginning to form. It is use that, in a great measure, extends them continually as they advance in life. There is, no doubt, a disposition in the bone to enlarge; but they are increased by use. And this consideration, also affords an argument against their being intended to supply the nose with moisture, for children have rather more moisture than adults,

though the sinuses are only beginning to form. Besides, comparing a variety of animals, the appearance of the sinuses does not vary with the acuteness of the smell; but the variation is within the open cavity of the nose. On attending, also, to what happens in ourselves, the openings are not most favourable for receiving the air in inspiration, when we smell most acutely; and if the membrane of the sinuses feels very acutely in drawing in a pungent substance, we should be sensible of pain in this as well as in the nose; for it has been alleged, that we do feel pain in the root of the nose; but whether is it in the os spongiosum superius, or in the ethmoid bone, or a little higher? The pain evidently does not extend further than the root of the nose, and never above the eye; and the antra maxillaria are extremely large, and yet we never find a violent pain in the cheeks in drawing in odours into the nose; and, as an irresistible argument, it may be observed, that in the time of inspiration, or smelling, the air does not enter the sinuses, but comes out of them. A small stream from the sinuses entering the lungs along with the external air, (the air in the lungs being now lighter than from the sinuses,) enters them for the same reason the external air does. And if we find small particles of dust within the sinuses, these are pushed in from the open cavity in the

time of expiration, the air rushing where there is a vent, endeavouring to expand on all sides, it enters the sinuses.

CCLXXVII.

It is therefore to be said, that the membrane being thin, and the bones hard, such a tremor is produced as renders the voice louder, and more harmonious. The use of sinuses may be, indeed, confined to this last purpose; and that they serve this purpose, appears from a variety of considerations. The voice is formed at a certain age, as the sinuses form; and we find, that when the membrane of the nose is thickened, the voice becomes harsh and disagreeable. Or, comparing the sinuses with a drum, we find a great analogy between them. Take the antrum maxillare, there is an impression made on the side of it, and it is shut by membranes resembling the parchment of the drum, and the opening in that instrument. And apply the finger to it in the time of speaking, you will be sensible that all the bones are at that instant under a tremor.

CCLXXVIII.

The last part of the head that awaits our examination is the ear.

CCLXXIX.

Ear.

The skin of the external ear, or ala, is supported by cartilage. It is divided, at its fore

part, into several cavities; and, besides the muscles connected with the head, the superior attollens aurem, &c. there are a few very short and very pale coloured muscular fibres, which begin and end on the external ear, and which are already demonstrated (Vol. I. CCCXXXV).

CCLXXX.

Of the ala, the outer bar, or margin, is termed the helix, from its bending direction; and it divides the concha into two parts. The inner bar, or margin, termed the antihelix, consists of two ridges, placed within the former, that unite below. Over the external passage is a small eminence, the tragus, connected to the under and fore-part of the helix, and is distinguished by the hairs that grow on it. Opposite to this is the antitragus, then the nameless cavity situated between the helix and antihelix, next the scapha, or boat-like part, between the limbs of the antihelix, and following that is the concha, or cavity under the antihelix, the inferior part of which leads to the meatus auditorius.

CCLXXXI.

From this part there is a passage inwards, the outer half of which is composed of the same materials as the external ear; but the inner half, in the adult, is osseous. In a child, the whole passage is soft or cartilaginous, and the bone only by degrees encroaches upon the cartilage.

CCLXXXII.

At the bottom of the external passage, which is lined by a fine membrane, we find wax, or a bitter substance like bile inspissated, and which is separated from minute glands. This membrane is semi transparent, looks like a bit of the pleura or peritonæum when wetted with water, and vessels are observable upon it. This membrane has no hole within it, but we find a large irregular shaped cavity, about the size of the last joint of the finger. That cavity is compared to the cavity of a drum; and therefore the membrane which is found covering it, is compared to the parchment of a drum, or named *membrana tympani*.

CCLXXXIII.

There is no passage then for air through the external meatus into the cavity of the tympanum, but there is a direct passage into it leading from the throat. The tube is named *tuba Eustachiana*, and it is of the shape of a trumpet, with the small end towards the ear, and, like the external meatus, the first half is cartilaginous, and the other half, towards the ear, osseous. The part on which the impression of sound is made, is at the bottom of the cavity of the tympanum; but a connection is made between this and the membrane of the drum by a very curious chain of bones, four in number, and termed the *malleus*,

incus, orbiculare, and stapes. The fourth, or the stapes, is connected to a membrane, with an oval hole at the bottom, so named foramen ovale. Within that we find an enlargement of a cavity, and from that the ends of five, or rather six, semicircular hollow tubes. The enlarged cavity, in which they terminate, is named vestibule, and the canals begin and end in it. Two of these canals are joined, and hence there are only five openings.

CCLXXXIV.

There still remains one curious organ, like the shell of a snail, and therefore called cochlea, and this is turned round a gland. The bottom of the shell, which is a hollow tube, communicates partly with the vestibule; but the outer half terminates at a round hole shut with a membrane on the back of the cavity of the tympanum, and we find a partition dividing the cochlea the whole length.

CCLXXXV.

It is in these last named parts, the cochlea semicircular canals and vestibule, the portio mollis of the seventh pair of nerves terminates, spread out upon the membrane which lines them; and here, at last, the impression of sound is ultimately made, just as the impression of light is made upon the retina of the eye.

CCLXXXVI.

The chain of bones which play upon one another, is not merely formed by membranes, but small muscles are likewise connected to them. An external muscle has been mentioned as at the bottom of the meatus; but this is hardly to be found. But there are three others; one of them follows the course of the Eustachian tube, and is connected to the malleus, which it draws a little out and nearer to the middle of the head. It lies parallel with a nerve, the branch at the root of the lingual branch of the fifth pair, and it passes through the cavity of the tympanum like a stretched chord, so called *corda tympani*; the fibres of the muscle are parallel, and a branch of the *portio dura* can be traced into it.

CCLXXXVII.

From this general view of the several parts, their use, and their manner of operating, fall next to be considered. First, we observe, that danger is guarded against; pointed instruments are hindered from entering the external cavities to the membrane of the drum, partly by the protection which the prominence, named *tragus*, gives to the passage; if we mean to stop the external passage, we press our finger upon the prominence. And the passage is not altogether straight, but a turn is made where the cartilaginous part joins with

the ossæus. This turn, however, is by no means so great, but that, by pulling backward the cartilaginous part, we are able to see to the bottom of the passage, and with the light of the sun to distinguish the membrane of the drum. Insects are hindered from readily entering, by the number of small hairs from the sides of it, and the very viscid wax, which is the chief or primary purpose of the cerumen, for it is not of any immediate consequence to fit the ear for receiving the impression of the sound.

CCLXXXVIII.

In like manner, the internal passage, the Eustachian tube, is guarded. There is little fear of our food or drink being squeezed into it in deglutition, for without supposing a contraction about its orifice, somewhat of a muscular power inherent in its membranes, the mouth of it is placed higher than the velum pendulum palati, and it is accurately shut by the elevator palati, and by the superior constrictor of the pharynx.

CCLXXXIX.

Proceeding then to the particular parts of the organ, we observe of the external ones, that the cartilage under the skin serves to enlarge the tube in which the tremor of the air is made. Not that we can demonstrate that the human ear is exactly formed for collecting every tremor; for, in attempting to assist the dullness of hearing, we find

other contrivances equally good, and we observe a great variety with respect to the shape in different animals, some of which hear more acutely than we do; but, by attending to the shape and winding of the passage, it is obvious that the sound reverberates as it is thrown into the meatus; and we have seen muscles of the head connected to the ear, which at least serve to give a tension to the part. Other animals assist their hearing by these muscles, pointing the bone of the ear towards the sonorous body, whereas we are under the necessity of moving the whole head, so that the direct impression is made upon one ear only, and there is no communication between the ears, as in a bird, which receives the direct impression upon both ears at the same time, a canal leading from the one to the other. The small muscles upon the cartilages serve also to give a greater tension, and to throw off the sound with an additional force.

CCXC.

Within the meatus auditorius externus, the sound is collected and concentrated, and the winding passage, instead of lessening, increases it, just as a sound appears louder in a crooked passage made by walls, than if the passage is altogether straight. Perhaps, the sound is thrown by the sides of the passage towards the middle of the concavity to the very place where the bones are

connected to the membrane, for it is the chain of bones that pulls the membrane inwards. Through the chain of bones the sound is communicated to the membrane of the oval hole or vestibule; *i. e.* to the three semicircular canals, and at least on one half of the cochlea; but the turns which the organ makes communicating, the whole cochlea and semicircular canals through the vestibule are affected.

CCXCI.

Since the small bones have muscles joined to them, it must be admitted that they serve to regulate the tension. And as in other animals the muscles of the external ear are spontaneously roused into action, so the internal ones are influenced likewise in the same manner. Now this may be carried farther; for they not only act when the sound is very low, and the tremor is not distinctly communicated, but also a tension of the chord is made with the sound, being thus more readily communicated to the chain of bones and to the membrane of the oval hole.

CCXCII.

Besides this, a general vibration is communicated also to the air within the cavity of the tympanum, and which is conveyed there by the Eustachian tube; for, unless the tremor had affected the air in general within the cavity of the tympanum, that passage might have been wanting. If it was only necessary that the sound

should be conveyed through the chain of bones, there was no necessity for air within the bones; and there is no doubt, that were the small bones taken out, without a læſion of the parts, ſtill we ſhould be able to diſtinguiſh the variety of ſound.

COXCIII.

On conſidering the irregular ſhape of the cavity, and the communication it has with the cells of the maſtoid proceſs, it might be ſuppoſed that the ſound collected in the cavity was conſiderably ſtrengthened, its being diſuſed in a cavity of ſuch ſhape, and the ſides of it are made of hard bone, adapted for tremor, and the outlet is ſmall. A ſtriking analogy is afforded between this part of the ear and the common inſtrument, the membrane reſembling the parchment of the drum, the cavity within, and the Euaſtichian tube, the cavity and holes in the ſide. As the ſinuſes, communicating with the noſe, increaſe the voice, and render it more melodious, ſo the ſame thing may be applied to the ear; and, if a tremor is communicated by the cavity, the ſound in that manner is increaſed, and applied through the ear to the bottom of it. And this is a ſecond manner in which we receive the impreſſion; and one half of our cochlea terminates at the membrane ſhutting the foramen rotundum, and has no immediate connection with the chain of bones.

CCXCIV.

A third manner of communication has been supposed, that the tremor is communicated to the parts within, directly through the Eustachian tube, serving the same general purpose with the external.

CCXCV.

Thus, there are two chief ways in which we receive the impression of sound : one through the chain of bones, the other through the membrane of the tympanum and the air in the cavity. There is another way, that has no inconsiderable effect, the general tremor of the bones of the head and of the whole body. So persons in whom the external ear is corroded, and the chain of bones perhaps destroyed, distinguish very loud sounds in this way ; and if you apply any tremulous substance to the jaw bones, as striking the grains of a fork, you hear as it were a very loud sound. The common account here is, that the nerves are connected, so the tremor passes from one nerve to another ; but still the sound is much more distinct when the tremor is communicated to the teeth of the upper jaw, though they are the nerves of the under one that are chiefly connected, a branch of the fifth pair being connected to the seventh ; and that observation may be applied to practice, with considerable relief. Thus, if we want to converse with a person dull of hearing, a thin piece of very hard wood may be taken that can have a tremor

easily communicated to it, one end is applied to his fore teeth of the upper jaw, and the other end of it is put into your mouth, and by speaking, he will apprehend what you are saying, though he is not able to hear a single letter, if the bit of wood be removed; so it is communicated through the bones which impress the nerves of the ear, as they receive the impression from the tremor applied in the other two ways.

CCXCVI.

By receiving an impression in different ways, perhaps we judge better of a sound than if the tremor is communicated in one way only.

CCXCVII.

The use of the Eustachian tube seems confined to one purpose chiefly, to supply the cavity of the tympanum with elastic air, properly warmed before it reaches the very tender parts of the internal air. Another purpose of it is perhaps to convey moisture, or fordes, collected by the secretion within the cavity of the tympanum; and this may be more necessary here where the air is admitted; for, as the substances floating in the atmosphere are conveyed into it, these should again have a proper outlet.

CCXCVIII.

It remains to determine the way in which the impression is conveyed from the membrane of the

oval and round holes to the portio mollis of the auditory nerves; for, after bringing the nerves to receive the tremor, we can give no further account why we judge so accurately of sound, any more than we can explain the effect that the objects of sight have upon the retina; and the question that occurs here is this? Whether are we to say that the tremor is communicated through air filling the cavities of the vestibule and semicircular canals, or are these replete with water? Upon the whole, it would appear that the tremor is communicated to water, and through the water to the nerves.

CCXCIX.

In regard to the great size of the semicircular canals and cochlea, they are proportionally larger in a child than the corresponding bones; the reason of which is, that a very considerable hardness of bone, capable of tremor, is here necessary; and these hard bones do not grow in the same proportion with the rest of the body: as with regard to the teeth, nature does not so readily increase the hard parts so quickly as the soft, and there being no room for making a change here, as in the teeth, these parts are cast in a larger mould.

CCC.

In examining the circulation of the ear, we find that the arteries of the external ear come anteriorly from the temporal, and posteriorly from the

occipital, both being branches derived from the external carotid; and its veins pass partly into the external, and partly into the internal jugulars. The origin of the posterior auris is from the situation of the parotid. It passes under the styloid process, and goes up directly behind the ear; and after giving branches in its progress, it distributes one twig, termed *arteria tympani*, to the lowest part of the cartilage, which spreads itself on the drum of the ear, and in the child it is particularly large. Its next branch, of considerable size, enters the mastoid hole as the great nerve of the face comes out, and this artery divides upon the tympanum by a branch surrounding the bony circle, and then spreading over the membrane, another twig supplies the muscle of the stapes and the semicircular canals. Branches also play round the back part of the concha, or shell of the ear.

CCCI.

The nerves of the ear are numerous from various sources. The forepart of the ear is supplied with nerves from the 3^d branch of the 5th and the portio dura of the 7th pair: the under and back part, by branches from the 1st and 2^d cervicals. But the chief nerve of the ear is the auditory one. It is composed of two branches, one of which is called the portio dura, and the other the portio mollis. The trunk of this nerve passes into the external meatus, covered by the

investing membrane of the brain. The portio dura distributes its branches on the stapedius muscle and mastoid cells. The portio mollis divides into two parts, one supplying the cochlea, the other the vestibule. Thus the portio mollis forms the primary part of the organ of hearing, to which all the others are subservient, and is the same expansion to the ear that the retina is to the eye.

CCCII.

Chemical Analysis of the Secretion of the Ear.

The secretion of the ear is in small quantity in health, and it assumes at times a solid cylindrical form from the attraction of oxygen from the atmosphere. It is of a yellowish colour, of an unctuous or waxy consistence, and bitter to the taste, without becoming rancid while retained in the ear.

Its constituent principles appear to be ;

1. Animal mucus.
2. A ceraceous part, or oil, inspissated by oxygen.
3. A bilious principle secreted from the blood.

The Eustachian tube secretes a mucus which passes into the fauces, but differs in nothing from mucus elsewhere, consisting merely of inspissated lymph.

The cavity of the tympanum is filled with an insipid water, which has no taste or smell, but becomes white, and is inspissated by the sulphuric acid.

CCCIII.

Descending from the parts last demonstrated, we come to examine the throat. It consists of three divisions, the arches of the palate, the pha-

rynæ, and larynx, and each of them were already partially considered, from their connection with the muscles.

CCCIV.

Arches of the Palate.

The arches of the palate are formed by a doubling of the skin, joined by some muscular fibres arising anteriorly from the middle of the velum, and fixed to the side of the edge of the tongue; and posteriorly from the same origin, but passing down by the side of the pharynx.

CCCV.

The anterior arch composes, with the muscles described (Vol. I. CCCXXVI.), the isthmus faucium. The posterior incloses the levator muscle; and between the two arches, close by the bone of the tongue, is situated the amygdalæ, of an almond figure, reddish colour, full of communicating cells, and with large irregular openings for the discharge of mucus into the throat, the quantity of which is promoted by the action of the adjacent parts.

CCCVI.

Pharynx.

The pharynx was discussed in (Vol. I. CCCXXVII.) Its circulation is conducted by the pharyngeal branches, which come directly or indirectly from the external carotids, and its blood is returned to both the jugular veins. Its nerves are derived from the 8th pair.

CCCVII.

Larynx.

The larynx, the last division, was also demonstrated at length, (Vol. I. CCXCIX.) with its several appendages. The circulation of this part depends also on the external carotids in part, for they give off to it the two superior laryngeals: but it has another, likewise, from the subclavian artery, or the two inferior laryngeals; and its blood is all returned to the external jugulars. Its nerves are prolongations of the 8th pair.

CCCVIII.

Trachea.

The continuation of the larynx, or the trachea, forms the passage to the lungs. It is of a somewhat conical figure, at first cylindrical, capable of admitting a finger in size, and narrower at its under end. It passes into the thorax behind the sternum, between the pleura; and, at the fourth vertebra of the back, or curvature of the aorta, it divides into two branches, termed bronchia, one to the right and another to the left, which enters the lungs, the right side being shorter than the left, in opposition to what takes place in respect to the pulmonary arteries.

CCCIX.

Bronchi.

The bronchi are spread on the lungs, and minutely dividing, at last terminate in the cells which

have a free communication with each other, so that the introduction of air into the bronchial branches inflates a portion of the lungs.

CCCX.

The trachea is formed, for the purposes of firmness and strength, of from 16 to 18 cartilaginous rings; and by this structure it is preserved constantly pervious for the transmission of air. Behind these rings are incomplete, and the trachea is even fleshy, in order to yield to the action of the œsophagus in the time of deglutition. These cartilages are placed horizontally to each other; they form a large segment of a circle, and they are united to each other by a firm ligamentous substance; though, in their upper part, little or no space intervenes between them.

CCCXI.

The division of the bronchi is distinguished at first by the same structure, but, as they enter the lungs, the circle of the cartilage is broken into pieces, and only so much is preserved of it as to keep the passage open and free.

CCCXII.

This structure of the trachea is defended by several coverings, both to strengthen and give it motion. The first of these is a cellular matter, covered on its entering the thorax by the mediastinum. The second is an elastic ligament, passing

along it, and adding to the elasticity and firmness of its branches. The third is a muscular coat, chiefly conspicuous between the rings and at the back of the trachea, and possessing, externally, circular fibres for straitening the passage, and internally, longitudinal ones for shortening it. These longitudinal fibres are the most extensive, and pass far into its branches in the lungs.

CCCXIII.

The internal surface of the trachea is lined with a vascular irritable membrane, every where possessing a mucous and lymphatic secretion. The existence, therefore, of mucous glands and exhalant vessels, is every where to be traced on this surface. But, besides this, for the same purpose of defence from irritation, some farther glandular appendages are connected with this part. These are the thyroid gland, the tracheal glands, and the bronchial.

CCCXIV.

Thyroid Gland.

The thyroid gland, so termed from the cartilage formerly described, is a large reddish mass behind the sterno-hyoid and sterno-thyroid muscles, at the under and fore part of the larynx. It descends a certain way upon the trachea and œsophagus, and it possesses two lobes joined by an intermediate portion. From the viscid liquor it seems to secrete, and its internal granulous

appearance, its office we would infer to be, to lubricate the adjacent parts. For this purpose it is supplied with large blood vessels and nerves from those of the larynx, but still no excretory duct has been discovered in it to render its use certain.

CCCXV.

Tracheal Glands.

The tracheal are a numerous set of mucous glands, situated in the muscular coat of this membrane, and extending also into the lungs. Their office is evident, from each possessing an excretory duct that throws out a mucus on the surface of the membrane.

CCCXVI.

Bronchial Glands.

The bronchial glands occupy the cellular substance at the under part of the trachea and roots of the bronchi. They are of various sizes, of a bluish or dark colour, resembling some parts of the lungs, and they are evidently, when examined, of a lymphatic nature.

CCCXVII.

The circulation of the trachea is supplied by the inferior laryngeals, and its nerves are portions of the recurrent and great sympathetic pair. The lungs possess, as it were, a double circulation, the one by the pulmonary vessels, and the other by the bronchial.

CCCXVIII.

The use of the pulmonary circulation was already explained in considering that of the heart. This circulation is carried on by the pulmonary artery dividing into two branches of right and left, which are dispersed through the substance of the lungs, and form by their minute branches plexus, giving out the halitus expelled by the organ in expiration. The pulmonary veins join in four principal trunks, which collect the blood, and return it to the left auricle of the heart; and the veins through the whole substance of the organ bear an inferior proportion to the size of the arteries.

CCCXIX.

The bronchial circulation again, or that peculiar to the lungs, is conducted by means of three or four small branches, which, except one arising from the right superior intercostal, are all from the aorta. They are minutely dispersed on the bronchi, in the glands and lungs, and they are found to communicate with the pulmonary artery, so that the nourishment of the organ cannot be their sole use. Their blood they return to the vena azygos and left superior intercostal vein.

CCCXX.

The nerves of the lungs are small in proportion to the size of the organ. They are chiefly derived

from the 8th pair, and also in part from the great sympathetic.

CCCXXI.

From this view, a large apparatus is provided for the secretion of lymph and mucus to lubricate and moisten the surface of the passages to this organ. Hence it would appear necessary that this large supply should be afforded to guard against the action of the gaseous fluids, which are constantly extricated by expiration, and which thus unfolded, might act too powerfully on the passages through which they are expelled, producing inflammation and other consequences.

CCCXXII.

In a former part, we considered in a general way the structure of the lungs, but it is only when fully examining that of the trachea, or the passage into them, that their minute parts come properly into review; the principal and most important of these minute parts, as the ground work of their structure, is the air vessels. The trachea is composed of membranes, with muscular fibres and rings of cartilage, which are imperfect behind. This allows the food to descend in the œsophagus; and the circle not being complete, the trachea in the respiration and formation of the voice, alters its length and distension more readily.

CCCXXIII.

When we follow the trachea to its division

into branches, a similar structure takes place a great way through the substance of the lungs; but as now there is no reason why the defect should be only in the posterior part, the segment makes perfect portions of a circle in the whole circumference, till the tubes become membranous; and these terminate in cells of a similar structure, so far as we may judge by the eye.

CCCXXIV.

These ultimate branches of the trachea can be seen with the naked eye. The minute cells are found to communicate freely with one another, so that if we blow air into the small branches, a much greater portion of the lungs is inflated, and from a single lobule we can fill the whole lobe; so every cell of the lungs has not its corresponding branch, but they are more numerous, and the cells are so extremely minute, that upon entering into a calculation we are surprised with the vast extent of surface; and the pulmonary artery has a very minute division, every where giving redress to the sides of the cells.

CCCXXV.

The air within the cells is confined by a membrane proper to the lungs, and this membrane is more extensive than merely from viewing the lungs we would conceive; for the division into
les goes to a great depth, and these divisions

of the lungs into lobules, allow them to accommodate themselves to the size of the thorax, every part to be expanded in the most equable manner. That their play upon each other may be the easier, and they may the more readily retract, a cellular membrane enters between the lobules; and the whole is covered over with the pleura, without any communication. It has been supposed that the cells communicate with the common cellular membrane, the consequence of which must be the diffusion of the air in the interlobular cellular membrane, and from that over the whole body; hence we should be exposed to emphysema and to anasarca in the lungs, the water making its way into their cavity. When the lungs are taken out sound, we can indeed, upon blowing in air, make it go into the interlobular cellular membrane, and we are apt to imagine that when we do this with the force of our breath, the same violence is done to our own lungs; but our lungs are prevented from over distension by the containing parts of the thorax, so that we can burst lungs that in life were stronger than our own; and before opening the thorax, we are often not able to make injections pass into the cellular membrane. Thus we may compare this membrane proper to the lungs, to the pia mater of the brain, whilst the pleura is represented by the tunica arachnoides. It chiefly allows the lungs to play

upon the ribs without being injured, so the ribs are lined with the continuation of the same membrane.

CCCXXVI.

Practical authors treat the cells of the lungs as possessed of a truly contractile power, and they suppose that the appearance of suffocation depends upon the contraction of the cells of the lungs. That the vessels entering into the composition of the lungs may be spasmodically affected, is to be admitted; but there is no reason to suppose that the cellular texture is truly muscular in its appearance; and in different animals, when the lungs are irritated with a very acrid liquor, no immediately subsequent contractions ensue; and in the asthma the suffocation depends very much upon the affection of the glottis, the various affections of which are more frequently ascribed to the lungs than they ought; also whilst we admit the affection of the vessels of the lungs, we must regard the change produced on the glottis, which can be constricted on the most accurate manner.

CCCXXVII.

With regard to the circulation of the blood in the lungs, the same quantity of blood passes through the lungs in the same time as through the rest of the body; and the quantity and velocity are nearly the same in the pulmonary artery as in the aorta. The force, however, is very dif-

different from the difference of thickness in the two ventricles. In the aorta, the force is three times greater than in the pulmonary artery; but when we consider the divisions made by the pulmonary artery in the lungs, they are by no means so extensive as the divisions made by the aorta, and, therefore, though the force of the blood is greater in the trunk of the aorta than in the trunk of the pulmonary artery, the force in the extreme branches of the pulmonary artery is greater than the force in the extreme branches of the aorta; and on that circumstance depends an observation, that a wound in the lungs bleeds more violently than a wound of most of the ^{low}els belonging to the aortic system. Comparing the force of the two ventricles, the thickness of the left ventricle is three times that of the right; but the number of vessels of the aorta is fifteen times greater, for the lungs do not make above the thirtieth part of the weight of the body. Now, making an allowance for the earth of the bones, the fat and extravasated liquors, and allowing that the lungs are more purely vascular, the blood is still spent upon a field that weighs fifteen times as much; and, where the vessels are numerous in proportion to the weight, the number in equal portions is greater; for, upon injecting fluids, they pass more readily from the pulmonary artery into the vein than in other places of the body.

CCCXXVIII.

It is generally supposed that the veins are not in such proportion to the arteries in the lungs as elsewhere, but there is no such difference as is generally supposed. In the aortic system many veins run under the muscles, and hence there are two sets, and the cava is larger in proportion than the pulmonary veins. There is, likewise, an inequality in the size of the two sides of the heart; the right one is originally larger than the left, and, perhaps, the difference increases with use of years, because of the unequal stop in respiration, the blood passing with more difficulty through the lungs in the state of expiration than in inspiration when the vessels are drawn more out into straight lines, and the pressure of the air within the lungs is taken off, for the air does not so readily enter by the narrow passage of the glottis as to make the same pressure in inspiration as takes place in expiration. When the sides of the thorax are drawn in, from the passage of the air being difficult through the glottis, the pulmonary vessels come to be compressed.

CCCXXIX.

There is a minute division of the blood vessels upon the cells of the lungs, which appear every where red upon the vessels being injected, but there is no appearance, except of glands, for mucus, and yet a separation is made from the

extremities of the pulmonary vessels of a matter that is pernicious to animals, as already explained.

CCCXXX.

Besides the pulmonary vessels, there are other small but constant arteries derived from the aorta, the bronchial ones, the number varying in different subjects, and they make a very intimate division through the substance of the lungs. At first we might imagine that they are accidental *lusus naturæ*, from the aorta scattering itself on all sides, but we cannot doubt that material purposes are served by these vessels, though it is difficult to say what these may be. In like manner, the coronary arteries of the heart are derived from the aorta only; and, tracing these back, the veins terminate on the right side, though we should have imagined that they would have more readily gone into the left auricle with the pulmonary ones: and, in the liver, though we find a great quantity of blood furnished by veins, and forming the vena porta, we shall find a branch constantly from the aorta: so that it would appear that there are purposes necessary to be done in the various organs, which the whole mass of blood, or vessels carrying it through these organs, are not fitted to execute, or that a greater change is produced by a *single* circulation than at first sight we are aware of.

CCCXXXI.

It is generally supposed that the bronchial vessels serve for the nourishment of the lungs; but, though the nutrition depends upon the blood vessels, it cannot be with certainty affirmed that this is the purpose they serve, nor still less that it is the sole purpose. It can only be said that, by a single circulation a considerable change is made; and that, by a passage of the blood through the lungs, a something wanting is restored to it, and yet we shall find that all that is received by the absorbent vessels of the lungs, passes into the right side of the heart, and is furnished to the pulmonary artery.

CCCXXXII.

Following the bronchial arteries with care, they communicate with the pulmonary ones, and these anastomoses are sometimes found of considerable size.

CCCXXXIII.

A number of minute glands are observed on the back of the trachea, that make circles in the rings of the trachea, and which evidently pour out mucus. These glands can be traced in the larger branches of the trachea, and what is seen there may be applied to the most minute branches, as they must have a very extensive distribution here as in other places, wherever the air has access, or acrid liquors are applied, which require the separation of a mucous or sebaceous matter.

CCCXXXIV.

There is another set of glands, the use of which it may be more difficult to determine, the glands named bronchial. Some authors are disposed to arrange these with the lymphatic glands; but, when speaking of the secretions in the trachea arteria, they are mentioned as performing a secretion. At first sight, there is a degree of improbability in the opinion, and they were led into it from this circumstance, that these glands from the division of the trachea are of a dark colour, and we throw out from the trachea dark blue coloured matter after twenty years of age, hence it is inferred that there must be a communication between the bronchial glands and the cavity of the trachea. But the whole matter is to be explained very differently: all the matter absorbed from the lungs passes to the right side of the heart; so the changes made upon the blood in this lesser circulation, do not depend upon a difference of mixture or parts.

CCCXXXV.

With regard to the colour of the matter in the bronchial glands, in a young subject nothing is observed of the black matter. In an adult, the colour of the lungs gradually changes from a brown to a black colour, and the same vessels which, by separating a certain substance, give

that black colour to the solid part of the lungs, by making a similar secretion into the cavity of the trachea, may give the same colour to the mucus. Thus the extremities of the pulmonary artery discharge, by the exhalant terminations, the black colour, and the bronchial glands giving passage to the absorbent vessels, receive the black tinge from the lungs. The trachea receives the colour first, and communicates it to the bronchial glands; and, as all the solid parts of our body are constantly undergoing a change, the solid mass of the lungs themselves will be in course gradually re-coloured by these absorbent vessels, so the colour will also be communicated in that way, and the colour of the lungs of these glands always correspond. From this, the bronchial glands serve a single purpose, that of absorption, and receive their colour from the lungs.

CCCXXXVI.

Having fully traced the circulation of the carotid, or first superior aortic branch, through the different organs it pervades, we next pursue the course of the second, or the subclavian. It consists of two branches, the left subclavian, and the right one. The former emerges from the aorta at its turn towards the spine, passing out of the chest obliquely, and receiving its circulation in an unfavorable direction. The right subclavian takes its origin from a common branch between it and

the carotid, rising on the top of the aortic arch, and receiving the blood in a direct current.

CCCXXXVII.

As the subclavians pass along in their progress, their name becomes changed. Within the breast they preserve their appellation, in the arm pit they are termed axillary, down the arm brachial, when dividing at the bend of the elbow, radial and ulnar, and in the head they are lost in a variety of vascular divisions.

CCCXXXVIII.

In its first division, or real subclavian course, it is protected by the bone of that name. It is here of great size, and runs directly across at the root of the neck, and it sends off a variety of branches both upwards and downwards.

CCCXXXIX.

The first of its branches passing downwards is the internal mammary; and, as this artery supplies the circulation of the breast, the structure of that organ becomes properly premised; and being an organ of more importance in the female than in the male, the female breast is preferred for examination.

CCCXL.

Breasts.

The female breasts are two glandular bodies; situated on the anterior part of the thorax some-

what laterally, and loosely adhering to the pectoral muscle: a situation which only distinguishes the human female and the ape, for in quadrupeds they are placed under the abdomen.

CCCXLI.

Though two are almost universally the number appropriated to women, in some rare instances a variety has been met with, as two on one of the sides, and even two on both sides.

CCCXLII.

The size of the breasts is very different in different females, and in no organ of the body is a difference of size so conspicuous. Previous to puberty they are always small; but they evolve, and become prominent as the menses take place. Their size is gradually increased by gestation, and comes to its ultimate magnitude after delivery. As child bearing departs from the age of 45 to 50, when the menses disappear, their size diminishes; and they gradually, in the advance of life, turn wrinkled and flaccid.

CCCXLIII.

The chief magnitude of the breast, in its ordinary state, is formed by a quantity of fat, which defends the glandular part; but does not, as it is alleged, pass into or communicate with the lactiferous tubes, or has a connection with the formation of the milk.

CCCXLIV.

The glandular, or secretive part of the breast, is of the conglomerate kind, of a whitish firm texture, and irregular in its substance. It is composed of a number of small follicular masses separated by fat, and these undergo most minute alterations.

CCCXLV.

Nipple, or Papilla.

In the centre of the breast is the nipple or papilla, in its colour, and cylindrical in its form, of various sizes in different females, and increased by the same circumstances which increase the size of the breast, being particularly liable to be distended by titillation and passions of mind. It is formed of tough ligamentous substance or a condensed cellular structure, which incloses the lactiferous tubes, is easily drawn out or distended, and from its elasticity collapses readily again when the distending cause is removed. Upon its point, or apex, are placed the lactiferous orifices, which correspond in number to that of the tubes, being from 14 to 20.

CCCXLVI.

Around the nipple is a conspicuous circle or disk, named the arcola, varying in colour from the rest of the skin, and deriving this appearance from a number of sebaceous glands which pour out a quantity of sebaceous matter to prevent the

skin from being excoriated. The colour of this disk varies at different periods of life, and under various circumstances. Thus it is florid in girls, pale brown in women more advanced, and it becomes livid and dull with age. Thus, also, it becomes darker in pregnancy than at any other time.

CCCXLVII.

The circulation, then, of this organ is supplied by the mammary arteries, external and internal. The former are sent off from the subclavian, as already noticed, the latter from the same artery in its further progress, when it receives the appellation of axillary, and the different divisions of these arteries enter the breast at different places. These are also accompanied by corresponding veins which receive the same name.

CCCXLVIII.

From the extremities of the arterial circulation of the breast, arise the lactiferous tubes, which are extremely numerous, and gradually unite into trunks, running in a radiated manner round the circle of the nipple. They form the reservoir of the milk, and are accordingly considerably increased in size in the time of suckling.

CCCXLIX.

At the root of the nipple the number of lactiferous tubes becomes contracted from 14 to 20, their number varies much in different subjects,

and they have therefore been variously represented by different authors.

CCCL.

They have been also supposed to possess a circle of communication, but this is disproved by the course of injections. The situation of the tubes in the nipple is peculiar for the purpose of preventing a spontaneous flow of the milk.

CCCLI.

This peculiarity consists in their distance from each other, and in the coiled up form in which they are placed. Thus, when drawn out and extended, they become straight, but easily recover their former situation on the extension being removed, or they become narrower and crooked.

CCCLII.

Though the secretion of the breasts is the effect of conception, yet a fluid is frequently formed in them in other situations. Thus, at birth, the cutaneous tubercle of the infant's breast contains often a milky liquor, and continued sucking has often brought to the breasts of girls and old women an appearance of milk, nor has this fluid been wanting in men on the application of the same means.

CCCLIII.

Sucking is an operation which, in some respects, resembles the principles of the air pump.

But the child does not merely apply the lips round the nipple, and then make a void in the mouth, but it assists the elongation of the nipple, and stimulates it so as to cause the filling of the cells, or the child takes hold of it with the tongue, and drags it mechanically into the mouth, using the tongue like the sucker of a syringe, and the membrane of the lips of the child is swelled and raised for excluding the air, which has been mistaken for a diseased state of these parts, and the tongue being drawn back for making a void, the pressure of the air upon the breast pushes the milk where there is the least resistance. But, by an instinct of nature, the child adds somewhat, for it applies the hand to the nurse's breast, and even, at the same time, uses the feet to press against the side, that they may act with greater force.

CCCLIV.

Chemical Analysis of the Secretion of the Breasts.

The secretion of the breasts, or milk, is a fluid, white, opaque, inodorous, and sweet. It is of an oily and aqueous consistence, a drop falling on the nail should flow slowly down.

This secretion begins in the last months of pregnancy, and appears on the second or third day after delivery by a fullness and distension of the organ. It is first separated of a somewhat serous nature, termed the colostrum, but soon acquires its proper quality.

This secretion continues so long as the child con-

continues to suck, even for years, and is only interrupted by a fresh pregnancy.

The quantity secreted in a given time, is various in different women, and depends much on the quantity of nourishment and other circumstances, but not more than 2 lbs. of milk have been considered as arising from 5 or 6 lbs. of meat.

This secretion is found naturally to separate into three parts, an oily, coagulable, and watery part, and this separation takes place sooner in an increased temperature than otherwise; and it is also promoted by salts and particular coagulable plants.

The constituent principles of the milk are;

1. An aroma, or odorous principle, which flies off when fresh drawn.
2. Water, which constitutes its greater part; for, from 1 lb. 11 oz. of water are procured.
3. Oil, or cream, which swims on its surface after standing.
4. Cheese, or coagulum, which separates from the other parts, and falls to the bottom.
5. Sugar, procured by evaporation of the serum.
6. Various neutral salts, as tartrate of potash, phosphate of lime, &c.

These constituent principles, thus united, we next examine, as they exist in its particular parts.

Thus, its cream, which resembles the vegetable fixed oils, consists of carbon, hydrogen, and sebacic acid.

Its cheese, or coagulum, which is of the same nature as the animal gluten, is formed of carbon, azote, and phosphate of lime.

Its serum is a composition of its water, aroma, and sugar, with the neutral salts formerly noticed. Hence this part forms the medium, uniting by means of its sugar the cheesy and oily part with the purer aqueous.

The sugar itself is the basis of the saccho lactic acid, and forms also the acid of sugar; both which are procurable by a particular treatment.

The milk, like the other secretions, is much varied in its nature from a variety of circumstances; as,

1. From particular food. Thus a vegeto animal diet unites its parts more completely than any other, and it is not so liable to ascency as from vegetable diet alone.

2. From time of digestion. For the milk is best at a due period, or 4 or 5 hours after eating, when digestion is completed.

3. From period after delivery. For it is at first too serous, and gradually acquires more of the coagulable principle as the period of suckling advances. Hence old milk is improper for a young child.

4. From peculiar substances or medicines. Thus milk becomes impregnated with the odor of garlic, and medicines given to the nurse, by their change on the milk affect the child,

5. From passions of mind. Thus affections of the nervous system produce often such an alteration in the secretion, as most sensibly to affect the health of the child.

Anatomical Preparation of the Breast.

To prepare the breast requires much time and patience. A milk breast should be preferred; and the

first step is to remove it carefully from the body without wounding any of its parts. The nipple being next examined, a bristle is to be inserted into each of the excretory ducts, and into one of them the pipe is to be afterwards introduced, so as to distend them with quicksilver. When completely filled, the orifice is to be secured by replacing the bristle, and in this way each tube is to be filled by withdrawing the bristle; and after injecting it again, replacing it. When finished, the orifices of all the ducts are to be secured by a ligature, embracing the whole nipple when the bristles are entirely withdrawn. If any tube has given way, or been wounded, it must be next secured, and then all the fat and other extraneous substance is to be carefully dissected away; after which, the part is to be macerated to free it as much as possible from blood; guarding against putrefaction; after which, it is to be exposed to a current of air to dry as soon as possible. When dried, it is next to be preserved in fine oil of turpentine, which will render it transparent, and display the distribution of the lactiferous tubes.

CCCLV.

The internal mammary artery sent off, as formerly noticed, from the subclavian, is about the size of a crow quill. On each side of the chest it passes down along the inner surface of the sternum, and terminates at the ensiform cartilage by numerous anastomoses with the epigastric artery; and this connection of the two arteries is intended merely to guard against obstructions. Yet more

material consequences have been supposed to attend this communication, for it has been supposed that the flow of milk, after delivery, depends upon it. Immediately after delivery there is a great discharge from the uterus; and in consequence of the mouths of its vessels being so freely opened, the push is lessened into all the other vessels, so it is several days before the milk appears. But as soon as, by the contraction of the uterus and the blood coagulating in the mouths of the vessels, a small quantity is circulated through the body of the uterus, there is an increase of the momentum of the blood in the epigastric artery to the mammary one, which is supposed to occasion the flow of milk.

CCCLVI.

But this is absolutely inconsistent with anatomical facts, and the theory cannot be reconciled with the general laws of the circulation of the blood; for if the flow of the milk depended upon the particular course of the epigastric artery, and the force of the circulation was increased in this, instead of finding that it only communicates by small branches with the internal mammary artery, we should have found it to terminate immediately upon the mamma: it is inconsistent with the laws of the circulation to suppose it. For are we to imagine that the blood runs from the smallest branches of the artery into its trunk?

This never happens, unless when the mammary artery is taken up with a ligature. And this is one use of the joining, that in case of an obstruction of the mammary artery, there may be a supply. But, in the ordinary course of the circulation, it is absurd to suppose that any blood enters the breast this way. The only effect is, admitting that less passes through the uterus, and that more enters the epigastric artery, the blood will not pass downwards by the small branches of the mammary artery, as before. But it is to be doubted, if the communication can have such an effect, for, before delivery, the uterus pressing strongly upon the descending aorta, and upon the containing parts of the abdomen, would make a greater resistance to the descent of the blood by the branches of the mammary artery than the increased momentum of the blood in the epigastric can do, so that the force of the circulation in the internal mammary artery is the same before delivery as after. This matter may be even brought to the decision of an experiment; for, if we were to cut through the rectus muscle, and divide all the communicating branches, we would still find the flow to the breast take place in the usual manner.

CCCLVII.

We must have recourse, therefore, to an explanation that depends upon very different prin-

ciples. Whatever idea we entertain of the cause of the menstrual flux, whether it depends upon a general or partial plethora, at delivery the constitution has been in the habit of preparing blood both for the mother and child; and that habit continues to remain for a certain length of time. For the first days, indeed, after delivery, there is a general debility from the openness of the vessels of the uterus, and the great discharge of blood; but when it is stopped by the blood coagulating in their orifices, and by the uterus greatly contracted, as the vessels of the body have accommodated themselves to the quantity of liquors they contain, and as every woman with child has the vessels immediately distended, there is still remaining a considerable degree of fulness; so that unless some outlet is given by the breast, by sucking, nature seeks an outlet some other way; the woman sweats very profusely, or is in danger of falling into some disease, as a fever. Hence there is the necessity of the separation of the milk.

CCCLVIII.

Besides, nature nourishes the child, before delivery and after it, nearly in the same manner, and by liquors nearly of the same nature; but there is a secretion in the uterus resembling that made in the breast. And wherever the nourishing vessels are collected into glandular masses, as in cows and sheep, we find in these a liquor in

colour and taste resembling the milk. In the human body the vessels are not so collected; but by their division upon the ovum a similar secretion is made.* And when that secretion comes to be interrupted, and the vessels recover their tone, then the flow is towards the breasts, just as when the perspiration is stopped there is a flow towards the kidneys, the organ that resembles that the nearest. And if the child is applied, by the sucking the flow is better determined, and that independent of other causes: this in animals that formerly had young will even bring again the milk. We conclude, therefore, that as the vessels of the mother had been in the habit of preparing more nourishment than was necessary for herself during the nine months of pregnancy, that this constitution for a certain time remains; and as the secretion made in the uterus resembles that made in the mammæ, when there is an interruption of the one secretion, there is an increased secretion in the other glandular organ.

CCCLIX.

While the internal mammary artery inosculates, as we have seen, with the epigastric, the external one does the same with the lumbar arteries. In its progress, as it passes down along the chest, it gives off several branches. One of the chief of these is the upper artery of the diaphragm, and its lower artery is the first branch of the aorta within the abdomen. The mammary branch ac-

companies the phrenic nerve in its course, and is spread out along with it on the diaphragm. In its progress it distributes small twigs to almost all the parts within the chest. Besides this, the mammary artery gives two branches to the pericardium, the one the upper, and the other the phrenico pericardiac artery. It distributes likewise many small branches to the mediastinum, and sends others to the interstices of the ribs.

CCCLX.

A second division of the subclavian is the thyroid artery, which buds out from its root, where it is named the great axillary, in the form of a short thick stump, and divides into four slender branches, which are distributed to the thyroid gland, trachea, and adjacent parts.

CCCLXI.

The vertebral artery makes its third great division, which plunges into the vertebral hole, and contributes to the circulation of the head in the manner already noticed. It is succeeded by two other branches, the deep and superficial cervicals, which are spent mostly on the neck.

CCCLXII.

Thus, in enumerating the divisions of the subclavian, the origin and progress of the mammary and diaphragmatic arteries are clear and distinct. The vertebral artery goes to the brain, and the cervical arteries supply the muscles of the neck, while the thyroid arteries supply the same place as well as the gland.

CCCLXIII.

After these branches follow the superior intercostal, which supplies the two first ribs, being about the size of a crow quill. In its course it runs downwards and backwards, and lodges itself in the hollow where the spine and first rib are joined. It gives off a number of small branches, one part of which rises to the neck, and another is sent downwards. The supra scapular is mentioned by some authors as an important branch, and often running off from the thyroid division.

CCCLXIV.

As the subclavian artery enters the arm pit, it is termed axillary, and from this place its distribution to the superior extremity proceeds. In the hollow of the axilla it lies safe, protected by the pectoral muscle before, and the latissimus dorsi behind, and surrounded with fat and glands. From this part it gives off the thoracic arteries to the chest, and the scapular arteries to the shoulder. Proceeding in its course, the axillary becomes soon changed to the brachial artery, and this division is marked by the tendon of the great pectoral muscle. This appellation it receives till it divides at the bend of the arm into the radial and ulnar branches. It runs close along the os humeri on its inner side, where the bone is almost naked, and keeps exactly the interior surface of

the arm bone, giving off frequent branches in its course, three of which only deserve notice, the two arteries named profunda, and the great anastomosing branch.

CCCLXV.

But the brachial artery thus described does not immediately divide, even after it has past the bend of the arm, but descends deep into the flesh of the forearm, and there its division takes place into three great branches, the radial, ulna., and interosseous arteries.

CCCLXVI.

The ulnar artery perforates the thickest flesh of the forearm, pervades the ulnar edge of the arm, appears superficial 3 or 4 inches above the wrist, and goes down to the root of the little finger.

CCCLXVII.

The radial artery passes in the manner of a branch from the ulnar, running to one side. It is more superficial on the forearm than the ulnar, and it turns backwards over the wrist, or root of the thumb.

CCCLXVIII.

The interosseous is an ulnar branch: where this artery lies deepest, it runs along the interosseous, and scarcely passes the wrist.

CCCLXIX.

Each of these arteries possesses a particular branch, termed recurrent, corresponding to the

anastomosing arteries elsewhere; which, so soon as it has cleared the principal branch, returns backwards to supply the joint.

CCCLXX.

The radial artery at the wrist turns round it over the head of the radius, and under the tendons of the thumb; and, before passing, it supplies the branch to the palm. When past, it sends off the artery of the back of the hand. Branches are then sent to the back of the thumb, and in its progress at the cleft betwixt the thumb and forefinger, it divides into three great branches, one to the inner side of the thumb, another to the forefinger, and the third into the palm of the hand; forming on the side of the palm, next the little finger, the celebrated anastomosis betwixt the upper and lower arches.

CCCLXXI.

The ulnar cavity, as it runs along the tendon of the flexor carpi, turns over the wrist at the pisiform bone; from this it forms the superficial arch of the palmar arteries, and supplies all the fingers, as the radial does the thumb. It sends also a dorsal trunk round the back of the hand to the little finger.

CCCLXXII.

Such is the general distribution of the subclavian to the trunk and superior extremity; and

in considering the origin of the subclavians from the aorta, the right one is more directly opposed to the mouth of the ventricle of the heart coming off from the aorta, where it is about to make the turn, whereas the force of the blood is broken by the turn before the other branch of the left side comes off. As mankind then, in general, prefer the right arm, there appears a connection with this fact, which may be received as cause and effect. This circumstance is a very curious one. The more the matter is considered, the more is it founded. For on comparing the nerves of both arms, they are of the same size, exactly connected in the same manner. The only final cause of the preference is perfectly evident, that by exercising one arm more frequently, we acquire much more dexterity. But we must find an efficient cause, or somewhat to determine us to use the one originally in preference to the other; for the great use proceeds not from reason. Children give the same preference, and we find it universal.

CCCLXXIII.

To this effect of the distribution it may be added, that though motion does not primarily depend upon the blood vessels, it does so in a secondary degree. The nerves exert their energy more powerfully by the quantity of the blood dispersed along them, and have seen many more vessels in the organ of

smell than we can well find use for. Now this trunk receives the blood with greater force and in greater quantity, and taking its rise in a common trunk, the resistance is much less, without at all alleging that the right subclavian is occasionally constructed larger than the left; the blood runs through the common trunk with greater ease than through the second and third branches, and there is less resistance made by the sides of the vessels. And to compare this with the case of other animals, notwithstanding the necessity they are under in walking to use the two anterior extremities exactly in the same manner, yet in them there is a preference: thus it is a very difficult matter to force a horse to walk with his left shoulder foremost, he naturally prefers the right fore extremity.

CCCLXXIV.

In birds, this preference would have been hurtful, and would have brought them to the ground, just as the cutting the smallest bit of one of the wings, by the lessening the surface, and thereby the force; whereas, when we cut an equal portion of both, the bird readily supports itself. In birds, then, the aorta sends off two branches, and these are again equally subdivided. Hence there is great room to suppose, that this distribution of the arteries allowing the blood to enter more perfectly and free to the

right arm, and perhaps to return more readily from the arm, gives the preference; and that it is stronger, and therefore originally preferred.

CCCLXXV.

When we follow the subclavian a little further, we find small branches sent off to the thorax, upper part of the shoulder, and lower part of the neck; after which the artery passes under the clavicle, and hence it is named properly, subclavian, passing between the clavicle and right rib, and we can at this place readily distinguish the pulsation, so experiments may be made, which may be useful, in a variety of cases, to stop the blood in the subclavian artery by a very slight pressure. If the thumb is put upon it above the middle of the clavicle, and pressed downwards against the first rib, the pulse ceases immediately, which is scarcely attended to by surgeons. Now, if an accidental wound in any of the large branches coming off near to the axilla take place, or in the external thoracic arteries, and if the surgeon is not provided with instruments for taking hold of the bleeding vessels, or if there is an aneurism in the axilla where there is no possibility of applying the tourniquet in the ordinary way, or if we are taking off the superior extremity at the joining of the humerus with the scapula, by making a pressure here we may prevent the great loss of blood.

CCCLXXVI.

Following the artery a little farther, we find it get into the axilla; and here it is protected by the pectoral muscle and latissimus dorsi, stretched across from the trunk to the body of the humerus, whereby the artery receives considerable protection, and the arm is much less wasted in persons that use crutches.

CCCLXXVII.

Next, from its situation between the round ball of the humerus and ribs, where a luxation happens downwards and inwards towards the axilla, the artery may happen to be very much compressed; and from this, independent of other circumstances, the arm may lose very considerably of its strength. From the pressure of the nerves here, a numbness is very often brought on, and this even continues sometime after the bone is reduced, the nerves being injured from the pressure it has suffered.

CCCLXXVIII.

Lower, we find the axillary glands connected to the artery by cellular substance; and where these are enlarged in a diseased state, there must be the utmost caution used in attempting to separate them from the artery, and the surgeon is under the necessity of tearing them away with the fingers, instead of using a knife.

CCCLXXIX.

Lower than this, the artery runs parallel with the os humeri, therefore is now named, humeral artery; and, in its whole course, is almost subcutaneous, or is not covered by any considerable muscle, but by the skin, cellular substance, and that condensed with a thin aponeurosis sent off from the muscle, so we can distinguish the stroke of it, through the whole way down the humerus, and are able to compress it in its whole course with the tourniquet; and the blood is more easily stopped here than surgeons generally apprehend. The tourniquet need not be drawn with great force, a very slight compression may be sufficient. And nature, in the whole course, has disposed the artery in the place of the extremity that is evidently the safest, running down parallel to the biceps at the inner side of the humerus, where it is least exposed to injury. At the lower part of this bone, an addition is made from the tendon of the biceps; the aponeurosis is now very considerably thicker.

CCCLXXX.

After the artery has run about $\frac{1}{2}$ of an inch under the bend of the elbow, it divides into the ulnar and radial branches; and following these into the hand, we find large communications of the arteries with each other; we find a superficial and deep arch; or, suppose an oval, or a circle, to be

made by the arteries around the tendons of the hand, that circle into one side of the trunk of the radial artery is opened with a small branch of the ulnar; and into the other trunk of the ulnar with a small branch of the radial; so that the blood may flow freely from the radial artery across these arches into the ulnar, and ascend in the ulnar in its whole length. From this merely we might conclude, that where radial or ulnar arteries happen to be wounded, the surgeon cannot stop the blood by gently compressing the artery, or by squeezing the sides of it together, but we may tie the wounded artery above and below the wound, and the circulation remains free through the whole member.

CCCLXXXI.

If the middle of the radial artery is wounded, all below would be supplied with the blood descending through the ulnar, and coming upwards from the arches into the radial. From the anastomoses we see also the necessity there will be, where these are to be stopped by ligatures, of making two ligatures, otherwise the bleeding will descend through the other branches, and get back to the wound. Not but that the bleeding may stop of itself by the coagulation of the blood at the mouths of the vessels; by their contractions, and by the swelling of the neighbouring parts, though it receives the direct impulse of the heart, and it

may be stopped more readily by the same means where the impulse is more indirect. But if we had no facts to support us, we could scarcely venture to draw any further conclusion with regard to the danger of wounds made in the trunk of the humeral artery. Merely reasoning upon it, we would suppose, that if the trunk is wounded, the limb under the wound could not be nourished, because the anastomoses are so small, that there could scarcely be a sufficient quantity of blood for that purpose; but experience determines otherwise, and we know certainly, from a number of cases, that after the humeral artery has been wounded, we may tie it in two places, and yet the motion of the blood continues through the arm in such quantity as is sufficient to maintain the common functions of the part. Hence, where a wound has been inflicted higher than the joint of the elbow, and there has been an uncommon division and only one of the branches has been wounded, or that the wound is more general on the radial branch, the trunk is more exposed than that branch, because the skin is thinner at that place, at the place of our flexion, in consequence of which the artery pushes forwards, and it is supported on the swelling of the extremities of the bones; whereas the radial branch sinks deeper between the muscles, and begins lower than the place

from which surgeons generally draw blood. Thus, in most cases, the trunk is found evidently opened; and, by the accounts of authors, the wound is always found to be several lines or parts of an inch above the division. Or take another view where the operation even has been performed in an unguarded manner; the patient has suffered, very exquisite pain, because the surgeon included the large radical nerve which is contiguous to the trunk, and, where the trunk divides, it follows the ulnar branch, not the radial; and the name of radial nerve seems to have misled some who have not seen this argument.

CCCLXXXII.

Thus it is sufficiently established, that the fore arm can be nourished by the lateral branches or recurrent vessels, taking their rise from the radial, ulnar, and interosseous arteries; and these gradually come to be dilated. Very often the dilatation is made before the operation is performed; and this explains a circumstance which has appeared very perplexing to surgeons; that, immediately on making a pressure upon the trunk of the artery by the ligature, the pulse ceased in the vessels at the wrist, but in the space of a few minutes it could again be felt. For in the time of the operation, without supposing the faintness, there is a loss of blood, the vessels are emptied, the surgeon slackens his tourniquet, then ties the thread, and it re-

quires some time before the blood has descended so as to convey the impulse of the blood in the heart. But if the disease has continued such a length of time as to make such an enlargement of the trunk, if the tumor presses this artery against the bone, the branches will be dilated, so in a few minutes they are filled and the impulse communicated. But where the pressure is not considerable, so as greatly to interrupt the flow of the artery, the pulsation commonly ceases for several days, till the lateral branches come to be dilated. The recurrent branches have been even seen dilated to the size of the end of a common probe.

CCCLXXXIII.

Having thus proved that the trunk of the artery may be tied at the elbow, it may be concluded that that operation may be as well applied to any other part of the superior extremity. Or, if we now return to the distribution of the vessels, at the upper part of the arm we find a communication made nearly in the same way, a superior, and posterior scapular artery; and getting lower, we find a number of small branches, &c. And to shew this more clearly by an experiment, the trunk of the humeral artery may be tied in two places, and cut between them, suppose about the middle. An injecting pipe is then to be fixed higher than the place cut, and squirting in water, air, or milk, we can feel all the inferior branches.

Thus the operation which is done near to the elbow, may be practised any where in the upper part of the humerus with nearly the same success, only a greater portion of the member needs to be nourished. And cases have occurred that prove it in the most absolute manner. An aneurismal sac has occasioned a concretion of the sides of the humeral artery near to the axilla, an effect the same as that of the ligature, and a proof that the artery may be tied above this ruptured place. Even from this, however, it does not follow with an absolute certainty, that any arm may be saved though the humeral artery is tied to that height; the concretion must be gradual in proportion to the increase of the aneurismal tumor, so the lateral branches will dilate by degrees; but in the case of a wound, the branches may not be sufficient to convey the necessary quantity of blood. But, instead of immediately proceeding to amputation, we should attempt to save the arm.

CCCLXXXIV.

Having now attended to the common division of the artery, it is of use to observe, that *lusus nature* are more frequent than anatomists are aware of. Dr. Haller imagines that they have not been so frequently observed as they are described. But instead of that, such may happen, upon the whole, in one of twenty persons; and a surgeon ought to look for it as in performing

the operation of the aneurism; especially that the two branches may closely accompany each other, and so both may be taken up. But if the surgeon is aware of this, the two branches may be separated with the greatest ease, and the success of the operation thereby insured, though the supply is the same as where one of the arteries happen to be wounded. In some cases they are afterwards united by a cross canal; but we are to take it for granted, that the supply is made through the small anastomoses or arch in the ball of the hand; and the necessity of larger anastomoses is evident, that part being more exposed to compression, and the stagnation of the blood in the vessels.

CCCLXXXV.

One further *lusus natura* ought to be observed, that it sometimes happens that where the common division is made, the arteries, instead of remaining contiguous to each other, separate, and one of them is subcutaneous. There may be a danger, therefore, of opening an artery instead of a vein; particularly we ought to be cautious where we are about to open the branch in the course of the basilic vein.

CCCLXXXVI.

Having fully considered what belongs to the arteries, let us next take the veins into review.

CCCLXXXVII.

the considerable arteries are accompanied by

corresponding veins. These are more numerous than the arteries; taken together, they are larger; but taken singly, they are smaller: for there is no vein as large as the humeral artery for ordinary accompanying it, but two or more veins, and these frequently joined together, and the whole crowded with valves. Besides the accompanying veins, there is seen a set of subcutaneous veins, which are upon the whole larger than the deep veins, and these likewise are crowded with valves, notwithstanding that they run upon the surface of the muscles, and we see numerous anastomoses between the deep and subcutaneous vessels. All the circumstances clearly confirming, as with regard to the use of the valves, that they serve to determine the blood to the heart; that, although the moderate action of the arteries and muscles promotes the flow of the blood in the veins; yet, if that action is greater, we stop the flow almost entirely. When the muscles are acted with, the subcutaneous veins immediately swell, the blood being no longer able to get along the internal veins with freedom. Hence, in letting blood, the patient is directed to move the fingers; and if the motion made is slow, we see the blood flowing sometimes in the subcutaneous veins, *per saltum*, and producing an alarm as if an artery had been opened. There is at the outer side the cephalic vein, upon the inner side the branch

forming the basilic, and between these, the median cephalic and median basilic. If then the situation of the arteries alone is respected with regard to the veins and the tendons, and if the tendons are very sensible, we would let blood most readily in the cephalic or median cephalic vein. But, if it shall appear that the tendons have little sensibility, and that the danger of wounds, independent of the artery, arises from punctures of the subcutaneous nerves, we would perform the bleeding most frequently in the median basilic; and, as this vein is of considerable length, though it crosses the artery, you will always find room for opening it without making the orifice immediately over the artery: it does not run so much longitudinally, but we may keep it $\frac{1}{4}$ of an inch distant.

CCCLXXXVIII.

To finish the examination of the parts described, their nerves come last into review. The exit of the first nine pair or the cerebral ones, was already noticed. The 1st pair, or olfactory, the most tender in their structure of the whole, we found form a beautiful plexus spread out on the membrane of the nose. The 2^d, or optics, of a pure white texture, enters the orbits in a waving direction, and penetrates the eye-balls, to be expanded on the retina. The third, or eye-movers, passing out at the foramen lacerum, divides into

branches which supply the ocular muscles, and form a small ophthalmic ganglion. The 4th, or pathetic, the most slender of the whole, is distributed on the trochlearis muscle. The 5th, or trigeminum, the largest of the whole, forms the semilunar ganglion by the outside of the cavernous sinus, and from this ganglion sends out three large branches, the ophthalmic and two maxillary, which are again divided into an infinite number of subdivisions. The 6th pair are expanded on the abductor muscles of the eyes. The 7th pair, next to the olfactory, is the softest nerves in the body, and is distributed in two portions on the ear and face. The 8th pair is spread out on the neck, tongue, pharynx, and adjacent parts. The 9th pair is distributed chiefly to the muscles of the neck and tongue.

CCCLXXXIX.

Great Sympathetic Nerve.

After this origin and primary distribution of the cerebral nerves, falls to be noticed the great sympathetic, connected with most of the nerves of the body, and arising from a reflected branch from the 2d of the 5th pair, and from some small filaments of the 6th pair. It is expanded in its course along with some other nerves into a large ganglion on the neck, termed the superior cervical ganglion. At the under part of the neck it forms in the same manner another ganglion, termed the

medium, or inferior cervical ganglion, similar in most respects to the former, but admitting some variety in different subjects. From this ganglion principal branches are sent out, one of which, or the proper continuation of the trunk, passes to a 3d ganglion placed at the head of the first rib, and therefore the first of the thoracic ganglia. From all these ganglia a variety of nerves are sent off to the different adjacent parts, and which derive their name from their connections or distribution.

CCCXC.

Accessory Nerves.

The accessory nerves to the 8th pair come the next in course, arising from the medulla oblongata and upper part of the spinal marrow. After perforating the cranium they observe an oblique descent through the sterno-mastoid muscle to the shoulder, from which they send branches to different parts.

CCCXCI.

Spinal Marrow and Nerves.

We thus descend to the spinal marrow which is chiefly to be considered as the production of the lengthening out of the medullary substance of the brain and cerebellum; but, upon cutting it transversely, a small proportion of cortical or enneritious substance may be observed resembling that of the brain. The nerves are next every where in the whole length of the spinal marrow

in pairs, and every nerve has two origins, an anterior and posterior one. Bundles of threads compose the spinal marrow, and these are covered where they are about to go through the holes of the vertebræ by the dura mater, and at that place there is an enlargement, a ganglion or knot, bigger than the threads that form it, or than those that go out from it. Beyond the knot we find the nerves spread into anterior and posterior branches; the anterior are the largest, and all of them communicate with the nerve above and below. Now, from this circumstance, it is in vain, till more pains are taken, to pretend to determine exactly the muscles on which each pair of nerves terminates: we find all of them joined to one another.

CCCXCII.

The spinal nerves are distinguished on each side by numbers, according to the bones under which they pass. They proceed the length of 30 pairs. Of these, one passes under the head, termed sub-occipital, seven go under the vertebræ of the neck, twelve under the dorsal vertebræ, five under the lumbar, and five are sent from the pieces of the sacrum.

CCCXCIII.

The fasciculi which compose these nerves, vary in the different divisions in their length, and in the direction of their course; some running straight,

and others running oblique. The size also of the fasciculi corresponds to that of the nerves they go to form. The lumbar, and several fasciculi included in their covering, compose a bundle of cords, termed the cauda equina, from its resemblance to a horse's tail.

CCCXCIV.

The circulation of the spinal marrow is supplied by its own arteries, the anterior and posterior spinal ones, which receive many additional branches from the adjacent parts.

CCCXCV.

The anterior spinals arise from the vertebrals; and upon the beginning of the spinal column they unite into a common trunk, and the artery continues nearly of the same size throughout, receiving additions from the neighbouring vessels. In the neck the spinal trunk communicates with the vertebral, thyroid, and cervical arteries. In the back it receives branches from the intercostal, and in the loins from the lumbar arteries. It terminates at the under end of the spinal marrow.

CCCXCVI.

The posterior spinals arise from the arteries within the head. They are of the same length with the anterior, but are less in size, and continue separate through their whole course. They observe also a separate direction, and frequently

inofculate with trunks connected with the anterior ones.

These arteries of the spinal marrow are subdivided into most minute divisions spread upon every part of its substance and its membranes.

The veins accompany the arteries, and terminate in the venous sinuses of the spine.

CCCXCVII.

These sinuses consist of one on each side, which runs exterior to the dura mater lodged in the ligamentous membrane which lines the vertebral canal. They extend from the occipital foramen magnum to the under end of the os sacrum, and from their irregular appearance and subdivisions, they in many places possess the appearance of cells. At the different vertebræ they are conjoined by cross branches of a semilunar form, and at their upper occipital extremity they communicate with the occipital and lateral sinuses of the head.

CCCXCVIII.

From the spinal nerves, now considered, we proceed to those of the neck. And, in general, we observe of the spinal nerves, which take their rise from the spinal marrow, that they begin by two distinct bundles of fibres, an anterior and posterior bundle. These come to be joined together, and are covered by the dura mater; but further, where they meet, there is a knot or sub-

stance, which anatomists call ganglion, the nature of which is not perfectly understood. From the ganglion branches are sent off, and all the anterior branches are connected by arches, which represent the anastomoses of blood vessels, but are perhaps very essentially different. From these are bundles of them tied together in one sheath.

CCCXCIX.

Besides the connection which the cervical and spinal nerves have by their anterior branches, the neck produces also, as already noticed, a nerve named accessory, which runs upwards into the head, comes out with the eighth pair, is again connected with the other cervical nerves, and, lastly, all the cervical nerves are joined to the great sympathetic, or intercostal one.

CCCC.

The general purpose of this is, to prevent the nervous energy from being intercepted; which is fully displayed in the lower cervical, or brachial nerves, which are first joined together by their anterior branches, and afterwards separated again, and a second and third time reunited; or we observe a very curious plexus formed by them under the clavicle, and down into the axilla, what anatomists have named axillary plexus. It is no greater an enlargement than what might have been expected from the size of the nerves running

together; and we can distinctly trace the nerves through the plexus, so as to determine the nerves of the neck from which every muscle is supplied. Thus, if from two nerves, suppose the two first, the fourth, and fifth of the neck, nature intends to supply two muscles that are antagonists, the biceps flexor and triceps extensor, instead of the fourth nerve supplying the one, and the fifth the other, the half of each is sent into each muscle, and neither the fact nor reason of it has been properly attended to. It is plain that this is to guard against accidents; that if one nerve is divided, instead of losing altogether the use of the flexor, or extensor muscle, we lose the half of both; and it is better to be able to extend and bend the arm with half the force, than to have the whole flexion without the power of extension. It is not to enable us to act more freely; there is no foundation for that supposition. We find it universally maintained, that the superior trochlearis muscle receives a nerve, that we may act readily and easily with that. But there is some other secret purpose to be served; and we find the nerves supplying different muscles carefully united, the union repeated, and antagonist muscles supplied from the same roots, and the same muscle, when of unusual length, supplied from a number of nerves.

CCCCI.

Nerves of the Superior Extremity.

The cervical nerves, in getting into the axilla, form an irregular plexus, termed the axillary, or brachial, which surrounds the place of the artery; and this plexus sends branches to a number of the muscles, and furnishes also the external thoracic nerves: after this it divides into nerves of great size, which supply sensation and energy to the superior extremity. Their number is considerable, and their distribution intricate and extensive. When the principal or radial nerve reaches the hand, it comes off in three divisions, from which seven nerves of considerable size arise for the supply of the thumb and fingers. When the second branch or ulnar reaches the same place, it is chiefly expended on the back of the hand. Besides the brachial plexus supplying the superior extremity, this member also derives some addition from the intercostals.

CCCCII.

On the nerves of the superior extremity it may in general be observed, that the use of knowing their particular situation is evident, as in treating various cases of convulsion and paralysis, and in performing surgical operations, that we may avoid them, because they are never wounded or punctured without evident danger. And in proof of this, we need only attend to the bad con-

sequences from wounds of the small branches, and particularly those following blood-letting performed about the elbow.

CCCCIII.

From the extremity, we return to trace the nerves of the thorax, which, on each side, consist of the phrenic, or diaphragmatic part of the 8th pair, the great sympathetic, and the intercostals: Of these, the intercostals and diaphragmatics supply the pleura, or investing membrane, with small twigs. The heart, the principal organ, derives its energy chiefly from the great sympathetic and 8th pair; and from the same source is sensibility conveyed to the lungs. In the distribution of the nerves here, several important plexus are formed. The 1st is the anterior pulmonary plexus, which extends across the great branches of the pulmonary artery. The 2^d is the posterior pulmonary plexus, which lies behind the root of the lungs. The 3^d is the œsophageal plexus, which surrounds the œsophagus, and afterwards going through the diaphragm, is spent upon the abdomen. The 4th is the great cardiac plexus, formed by a number of nerves, and particularly necessary to the exercise of the functions of the organ. Besides which, we find a lesser cardiac, and two coronary plexus.

CCCCIV.

Thus the heart, as the principal organ, receives its supply from no less than thirteen separate

twigs or branches at least ; and, besides the nerves that descend, we are not certain but there may be others that ascend and enter into the substance of the heart. Upon the whole, we can observe, that nature carefully guards against the want of a proper energy. Thus, if from any accident or disease a part of its force should be lost, it is better that this should be general, than that any one part should be rendered paralytic. Hence the heart derives its nerves from a number of organs, and these are intermixed by the intervention of ganglia, a further energy proceeding perhaps from these.

CCCCV.

From the consideration of the importance of the organs upon which these nerves are spent, the danger of wounds in the nerves upon the neck is perfectly evident. If a considerable proportion of them is tied, the animal soon dies ; and, independent of the danger which attends the ligature or division of these nerves, we have reason to believe that there is the utmost danger to be apprehended where the 8th pair and intercostal run, upon their being exposed to the air, from an inflammation taking place, that alone will be found often fatal. Hence we are not rashly to undertake operations here. As for the aneurism in the carotid artery, supposing it to be small, and that it is in the surgeon's power to tie the artery in

two places by such a ligature on the carotis communis the animal has been known to survive; but, when any greater injury is done, the animal dies, and in such cases these nerves are in an inflamed state, and glued to the neighbouring organs.

CCCCVI.

When we compare the branches from the 8th pair with the proper dorsal or intercostal nerves, we observe a great disproportion. Perhaps all the branches from the 8th pair on one side are not equal to the size of one of the proper dorsal nerves: and from this we may in some measure understand what happens in practice. It is a point allowed, that what is called the pleurisy, the inflammation of the side of the containing parts of the thorax, is attended with more pain and harder pulse than the true peripneumony, where the inflammation is in the substance of the lungs. This may be in some measure explained. Several circumstances no doubt concur; but, without taking into account the difficulty arising from the inflammation with which the blood passes from the right side of the heart to the left to affect the pulse, we would say that, from the greater number of nerves sent to the side, its sensibility is greater, and the system more irritated. And one thing further, perhaps, may have effect, that the proper dorsal nerves are intimately connected to the

nerves which supply the heart. Though, therefore, we do not say that the sympathy depends upon the connection of the nerves in their progress, yet an inflammation fixing upon a branch, more readily affects the neighbouring branches than the distant nerves of the body. Hence the hardness of the pulse, and the quick jirk, is owing very much to the sensibility from these large nerves, which too is the cause of the pain.

CCCCVII.

The whole substance, indeed, of the lungs does not receive a nerve larger than one of the proper dorsal nerves, the divisions of it therefore must be exceedingly minute, and the nerves of the pleura very small. This is to be suspected from considering the use of the pleura, which, with respect to the lungs, is to give a strength to them to confine the air, and prevent a rupture. Another use is, that the lungs in respiration may play upon the ribs, the pleura is interposed to lessen the attrition, so that it is made for attrition. Now, do we perceive, either from the one use or other, any necessity for sensibility? A highly sensible membrane cannot be interposed for either purpose.

CCCCVIII.

Upon the whole, though the pleura has nerves, because it has vessels which are actuated by the nerves, yet these are small and inconsiderable in

number, yet it is capable of inflammation and of concretion, which may be the source of many disorders; but we are not to believe that merely the inflammation of the pleura is capable of occasioning fatal symptoms, and that these depend almost entirely upon the affection of the nerves of the side, which are large and numerous, and which it is not in our power to relieve, and which we cannot altogether refrain from using. When the pain is seated entirely in the lungs, the patient will suffer the highest degree of distress when the inflammation occupies the deepest part of the lung, both on account of the sensibility of the pleura, and of the distribution of the nerves.

CCCCIX.

Nerves of the Abdomen.

The nerves of the chylopoetic viscera are formed by part of the 8th pair, and of the great sympathetic.

The covering, or peritonæum, derives branches from all the contiguous parts, but the number is small, and they are unimportant: they consist of twigs from the inferior dorsal, the lumbar, the great sympathetic, and sacral.

CCCCX.

The two nerves composing the 8th pair, after supplying the lungs, run upon the œsophagus. In their course downwards they split into branches.

and from the opposite sides the branches are united. That branching and joining is repeated several times before we get down to the stomach, so that we are at a loss to determine from which side a nerve of the stomach comes; in general they come from both sides. And we find an anterior and posterior bundle called plexus; but we are only to understand that several nerves are included in the same sheath, but without knots or ganglia being formed. The remainder of the 8th pair passes from the back part of the stomach to the aorta, and joins it as soon as possible about the root of the cæliac artery.

CCCCXI.

In tracing the great sympathetic, it runs down the thorax, and is joined to the proper intercostal nerves. About the middle of the thorax branches are sent off, which uniting, form a considerable nerve that is spent almost entirely upon the abdominal bowels, so named the ramus splanchnicus. The rami splanchnici take the same direction with the posterior branches of the 8th pair, and they are joined to each other across the aorta, and at the same time they receive the 8th pair, so that these nerves meet about the cæliac artery; and at the meeting we find a prodigious enlargement without any evident cause, we would suppose that it is a cluster of small conglobate glands, or we

AND DISSECTION.

ccccx

find ganglia, and from its appearance it is called the femilunar ganglion.

CCCCXII.

From this ganglion nerves are sent off to all the chylopoetic viscera; and, as these scatter as they proceed towards the different bowels, there are others who call this substance *plexus solaris*, like the sun sending out radii to all sides. The nerves from it proceed along the arteries, are conducted by them, forming a net-work that we would take for cellular substance, and take their name from the arteries they accompany, as the *plexus celiacus mesentericus*.

CCCCXIII.

This femilunar plexus in which the several nerves are united, is much larger than we might have expected, or something more is done here than in several other plexus, where we can trace the fibres distinctly, whereas here we lose them. And, without supposing that there may be somewhat added to the nervous energy in the part, or that some purpose is served different from what the brain itself supplies, we find here an intimate mixture and incorporation of all the branches running downwards, nature guarding against the total interruption of the nervous energy in organs that are necessary to life. Thus it is better to lose the thirtieth part of the nervous energy of

the alimentary canal, than to lose the total power of the thirtieth part of the length of it; for, should a paralysis of a single foot of it take place, there would be an interruption to the discharge of the aliment, the action of the muscular coat of the alimentary canal contributing in a very principal way to this. So we may say, that in the semilunar ganglion there is an intimate mixture of the several nerves, and we may consider these nerves as derived from a number of sources, from the intercostal, connected with all the nerves of the spinal marrow, and several from the head; and the nerves may ascend from the lower parts of the spinal marrow, so that some of the nerves entering this ganglion may be derived from the bottom of the os sacrum. From the nerves every where accompanying the arteries, upon coming out from this plexus we can understand the danger arising from tumours near to the arteries, as in the case of aneurism, there is not only danger from it as affecting the artery, but from the accompanying nerve necessarily suffering.

CCCCXIV.

In considering the different abdominal organs, the nerves of the stomach we find most numerous in the cardia. The nerves of the stomach supply also the omenta. Of the intestines, the nerves of the small ones are most numerous. In the liver, the same observation may be made, compared

with many of the other viscera. In the spleen, the nerves are both numerous, and form an irregular plexus surrounding the blood vessels. In the pancreas, again, they are small. In the kidney, like the spleen, the nerves are both numerous, and they form a plexus which surrounds the vessels, and accompanies them. This plexus sends also branches to the renal glands. The bladder of urine is supplied by the sacral nerves and great sympathetic.

CCCCXV.

To finish our examination of all the organs contained in the thorax and abdomen, one only remains, which has been hitherto purposely omitted, as the reservoir of a particular system of vessels, the detail of which we as yet postpone.

CCCCXVI.

This is the thoracic duct, a small membranous-like canal lying in the back part of the thorax, and forming the principal trunk of the absorbents.

CCCCXVII.

Thoracic Duct.

It is situated behind the aorta, beginning upon the 3^d vertebra of the loins, and it crosses obliquely from left to right till it gains the right side of the artery. Thus situated, it forms an oval sac, the receptacle of the chyle; and passing between the crura of the diaphragm, it ascends in the thorax on the anterior part of the spine, between the

layers of the mediastinum. At last crossing behind the upper part of the descending aorta, it emerges from the thorax to reach the under part of the neck. There it passes behind the internal jugular vein somewhat higher than the subclavian, and turning downwards, composes an arch ending in the cavity between the left jugular and subclavian. Into this duct is poured the chyle and lymph from all the colourless, or lacteal, and lymphatic vessels, to be discharged, as we shall afterwards find, into the red veins.

CCCCXVIII.

Having thus traced the circulation of the ascending and descending aorta, and the several organs they pervade, we again return to the abdomen to examine the organs of generation peculiar to the sexes, which still remain.

CCCCXIX.

Genital System of the Male.

In beginning the genital system of the male, our demonstration commences with the testes, which are two glandular bodies situated in the cavity of the scrotum, the body of the one being sometimes a little larger than that of the other.

CCCCXX.

This part, the scrotum, is a continuation of the common teguments, more abundantly supplied with sebaceous follicles than elsewhere, without any fat in its cellular substance, and forming a

bag, or purse as it were, over the testicles. Upon its surface there is a superficial longitudinal projecting line, which divides it into two equal parts, and is named its raphe. Its inner lining, or cellular substance, is red, fibrous, and more condensed than elsewhere, receiving the name of dartos; and forming a partition, or involving each testicle singly, so as to prevent any direct communication by means of a fluid or otherwise betwixt the two. By this outer covering of the scrotum are the testicles supported and protected.

CCCCXXI.

Whether there be a foundation for the term of dartos muscle, for expressing a muscle under the skin of the scrotum, is doubtful. We see the part possessed of considerable power of contraction, and we observe a degree of redness here, but we shall find, perhaps, that there is more muscular power in our body than we are aware of. In particular, every part of our skin is muscular, for it accommodates itself to heat and cold in the living differently from what it does in the dead body; but the motions of the testicle within the scrotum, particularly when the scrotum is inflamed, does not depend upon the dartos so much as upon the cremaster muscle, which has such a connection with the cellular substance, that the skin seems to be moved by it, and it may promote the secretion as well as the excretion of the semen. The sep-

tum scroti may be considered as cellular substance, grown more dense by having the layers pressed against one another.

CCCCXXII.

The internal coats proper to each testicle, serve also somewhat for the same purpose as the scrotum. These are the vaginalis and albuginea.

CCCCXXIII.

The vaginal coat is a continuation of the peritonæum, or abdominal covering, originally descending with the testicle, and forming a sheath, or shut sac round it, which has no communication with any other part. In its manner of inclosure it resembles the pericardium of the heart, lying every where loose upon it, except where it is connected with the albuginea behind, and to such an extent is that looseness both above and below, as to allow a proper and free motion of the organ. By its external surface it is attached to the cremaster muscle, and thus to the inner surface of the scrotum. It assists, as already noticed, in the support of the testicle; and, by a secretion from it, is the free motion of the organ preserved.

CCCCXXIV.

Within the vaginal covering is the albuginea, or white coat, which proceeds also from the peritonæum, and closely invests the body of the testicle, to which, internally, it every where firmly

adheres. It is a dense, strong, inelastic membrane, of a smooth external surface, every where spread over the testes and epididymis, and conducting their vessels in the same manner as the mesentery does those of the intestines.

CCCCXXV.

The body of the testicle next exhibits a yellowish colour, and a pulpy appearance, of an oval form, with one surface a little flattened.

CCCCXXVI.

Epididymis.

At the outer and back part of the testes lies their appendix, or the epididymis, inclosed in the same covering with the testicle itself. This part joins at the upper part of the testicle by a rounded head. As it descends it becomes flatter and smaller, being attached behind to the body of the testicle where blood vessels enter; but at its fore part it remains loose, the tunica albuginea dipping here and forming a pouch. From the under part, where it forms by its firm attachment to the body of the testicle the cauda minor, it turns backwards, and sends out the excretory duct of the testicle.

CCCCXXVII.

The body of the testicle, when examined, is formed of numerous vessels of every description, but its principal composition is a collection of small tender elastic filaments, intricately convoluted, termed the terminal vessels, or tubes; and

disposed in bundles with partitions between them, formed of vascular and cellular substance

CCCCXXVIII

The commencement of these partitions is at the root, or near the back part of the testicle; and they extend in a radiated manner to the albuginea. Behind, the testicle is fixed by its vessels, forming the spermatic chord. Before, it is loose and free. From the ring of the external oblique muscle, the chord extends to the body of the testicle, being the united trunks of the different vessels of the testicle increased by a quantity of cellular substance. The cremaster muscle also covers the chord, and the peritoneal continuation internally from the vaginal coat is so closely connected as to form a part of it. By the manner in which these coats are spread no fluid can pass from the chord to the testicle, or take the opposite direction. The circulation of the testicle takes place by means of the spermatic arteries which arise on each side from the fore part of the aorta, a little below the renal arteries. They cross the psoas muscle and ureter, and descend to the under part of the belly behind the peritoneum, where perforating the ring of the external oblique, they pass into the spermatic chord. In their passage they give branches to the adjacent parts, and are much interlaced with their corresponding veins.

CCCCXXIX.

After this passage of the rings, they soon divide into very small arteries for the several parts of the testicle, to the amount of four or five. Two of these go to the epididymis, and two large ones to the testicle; one of which moves in its upper part in a beautiful serpentine form under the epididymis, and sends coronary branches down all over its surface. The subdivisions of these are at last minutely distributed upon the surface of the seminal tubes.

CCCCXXX.

Besides the spermatics, a small branch from the hypogastric accompanies the vas deferens, and is dispersed along with the other artery.

CCCCXXXI.

The veins of the testicle are greatly larger than the corresponding arteries, and discover several valves in their distribution without the abdomen. They form a plexus on each side of the artery, so as to resemble the shoots of a vine. As it ascends in the abdomen, it forms at last into a single trunk on the right side, terminating in the vena cava, and on the left side in the renal vein.

CCCCXXXII.

To enter more minutely into the structure of the testicle, we find the seminal tubes of a cylindrical form, dividing into branches, and, when drawn

out they extend to an amazing length. They are collected first into larger, and then into smaller bundles, till each of the smaller is formed into a single tube, coiled up in a conical form; and from the convoluted tubes, straight vessels, or vasa recta, are sent out in equal number, forming an irregular plexus, or net-work, termed rete vasculosum. This net-work sends out again from 12 to 18 straight tubes, or vasa deferentia, which carry the semen from the testicle to the epididymis. These straight vessels then become convoluted, and form conical bundles, or coni vasculosi, firmly connected by cellular membrane, and which compose more than a third part of the epididymis. They at last unite into a single tube, which, constituting the most of the epididymis, forms the passage for the transmission of the semen. In its course it enlarges, becomes less convoluted, and, expanding its structure, it comes out in a straight direction, under the name of the vas deferens.

CCCCXXXIII.

Vesicula Seminales.

From the epididymis, we are led to the vesiculæ seminales, two pyriform receptacles, situated between the bladder and rectum, at a considerable distance from each other, and each composed of a convoluted tube with irregular processes, surrounded by vessels, nerves, and cellular membrane. Internally, they consist of irregular cells,

which communicate freely with each other, though varying in size and appearance in different subjects.

CCCCXXXIV.

Between these vesicles the vasa deferentia become cellular, and expand, passing forward till they arrive at the prostate gland, where they freely communicate with each other. Here a small canal is sent out from each of them, which pierces obliquely the prostate gland, and terminates in the under part of the neck of the bladder. The orifices of these canals are separated from each other by a caruncle, or round projection of the membrane of the urethra, termed the *verru montanum*.

CCCCXXXV.

Prostate Gland.

The prostate gland lies immediately under the symphysis of the pubis, resting upon the rectum. It closely embraces the neck of the bladder and beginning of the urethra. In size it is equal to a walnut, and in shape like a heart on cards, with its base to the bladder, and point to the penis. It is a firm gland, with some spongy substance, and it sends out no less than 10 or 12 ducts, which open obliquely at the sides of the urethra and adjacent parts.

CCCCXXXVI.

The circulation and nerves of these parts is

supplied by the same vessels that supply the genital system in general.

CCCCXXXVII.

In examining the uses of the parts described, we find, that while the convoluted structure of the testicle separates the semen from the spermatics, it is carried to the epididymis, and thence through the vas deferens by a long and slow course into the vesiculæ seminales. The use, however, of the vesiculæ seminales is undetermined, and they are supposed rather to separate a particular mucus essential to the perfection of the semen in its passage, than as serving merely for a receptacle of it. The secretion of the prostate gland serves also in a similar manner some useful purpose, of which conjecture only can be formed.

CCCCXXXVIII.

Thus the semen passes upwards through the testicle, then through the epididymis, to be deposited in the vesiculæ seminales, into which it regurgitates from the vas deferens, as the gall to the gall bladder from the liver; and, by a reverse motion, when necessary, it is thrown into the urethra. Near to the mouths of the seminal ducts we find the mouths of the prostate glands opening; and also Cowper's glands, the nature of which we do not pretend to explain: and in the whole course of the urethra, we find tubes pouring out mucus to defend the passage from the acrimony of the

urine, which, as it advances, presses out the mucus from them; and these are, beyond all doubt, generally affected in the gonorrhœa, though that disease may also affect the other parts.

CCCCXXXIX.

Penis.

The penis, the next part that follows, is composed of three spongy substances, two of which form the body of the penis, or the upper part, termed its corpora cavernosa, and the third surrounds the urethra, named its spongy body. They are all covered with a continuation of the common teguments, which are thinner than elsewhere, and which possess below a quantity of cellular membrane without fat.

CCCCXL.

These teguments form at its anterior extremity a loose fold, named the prepuce, which is connected to the glans, or under and anterior part, by a triangular fold or bridle, termed the frenum.

CCCCXLI.

In their shape, the corpora cavernosa resemble two irregular cylinders closely applied to each other, covered by a strong ligamentous sheath with transverse and oblique fibres. They arise also by two crura, or conical extremities, from the crura of the ossa ischii and pubes, to which they are connected by ligamentous substance. All the

under part of the symphysis they form a union which continues till they terminate in the glans or rounded extremity.

CCCCXLII.

From the upper part of the root of the penis proceeds a triangular process, connected to the symphysis, and named the suspensory ligament of the penis, by which its body is supported, and its pressure upon the scrotum prevented.

CCCCXLIII.

The principal vein of the penis runs in a groove in the upper part of the corpora cavernosa, and below in a channel left for the urethra. The internal structure of the corpora cavernosa is similar to the cancelli of the bones, and consists of loose reticular plates freely communicating with each other. Over the cavernous cells the arteries are freely dispersed, and open into them so as fully to fill them when distended, and to tinge them in the relaxed state. The junction between the corpora cavernosa is made by a continuation of their elastic covering, which forms a sort of partition, and this partition is composed of cords that run in a parallel direction from the upper part of the penis to the urethra. Between these cords fissures are left for the passage of the blood without obstruction.

CCCCXLIV.

The spongy body of the urethra lies under the

corpora cavernosa, and projects beyond them. It begins beyond the union of the corpora cavernosa, and terminates at the extremity of the glans. Its external covering, though the same, is more delicate than that of the corpora cavernosa. The posterior part of it, situated within the skin of the peritonæum, and extending from the root of the penis to near the anus, is dilated into a longitudinal prominence of a conical form, termed the bulb of the urethra, divided anteriorly by a septum.

CCCCXLV.

The glans, or termination of the spongy body of the urethra, anteriorly is separated from the corpora cavernosa by a continuation of their ligamentous sheath, and is encircled by a prominent margin posteriorly, termed the corona glandis, behind which is the neck. The surface of the glans consists of a venous plexus, and nerves continued in a fine membrane from the inside of the prepuce, which give it sensibility. The cervix and corona of the glans is beset with sebaceous follicles or glandulæ odorifera. The internal structure of these parts resembles that of the corpora.

CCCCXLVI.

The urethra, the next part, is a long canal, in diameter the size of a writing quill, terminating by a longitudinal orifice at the point of the penis.

after running from the under and forepart of the bladder through the corpus spongiosum. It descends somewhat at its origin, and then passes under the symphysis, to which it is closely attached by cellular substance. Three dilatations of it are commonly observed in the course of the penis: one at the prostate, the second in the bulb, and the third at the commencement of the glans. These are equalled by the same number of contractions, and this irregular structure, along with its particular uses, renders it so liable to disease. Between the point of the prostate and part where the urethra penetrates the corpus spongiosum about a finger's breadth, the structure is chiefly membranous, covered only by cellular substance. At the upper side the urethra becomes inclosed in the corpus spongiosum, which continues to its termination.

CCCCXLVII.

The lining of the urethra internally is highly vascular and nervous, with some slight power of contraction. Between the corpus spongiosum and the membrane, especially towards the septum, numerous lacunae, of different sizes, are placed; some of which, near the glands, are very large. They observe a longitudinal direction from behind forward, and perforate the urethra by small orifices discharging a thick mucus to defend it from irritation.

CCCCXLVIII.

Besides the lacunæ between the bulb and prostate gland, two small bodies, covered by the accelerator muscles, are frequently met with, having ducts into the urethra, and serving the same purpose with the lacunæ, named Cowper's glands.

CCCCXLIX.

Having examined the structure of the male organs, the use of the several parts naturally comes into detail, and chiefly the vessels and the ducts of the seminal organs. The first thing that strikes us, is the situation of the testes, originally within the body, and the length of the spermatic artery running so far before it terminates on the testicles. Some, of late, would persuade us, that there is nothing singular in the length of the spermatic artery, that it takes its rise from the place nearest to the testicle of the foetus, and is afterwards drawn out from necessity. Now this notion is to be rejected; for spermatic artery of a ram shews the same structure, and displays also vast numbers of convolutions which it makes in its descent to the testicle. By a calculation, if it was drawn out to a straight line, it would measure about 20 feet. And find that this artery is larger at the testicle than at its origin, notwithstanding that it gives off a number of branches. This arrangement cannot

be supposed to be made in vain; we must conceive that a change is made necessary for the preparation of the semen, that the length of the artery is of use in a manner that we cannot pretend to specify. From this view in other animals, we are tempted to draw a similar conclusion with regard to it in man, where we would have expected to find it taking its course in half way between its original place in the abdomen and its after place in the scrotum, *i. e.* about the bottom of the *iliaca communis*. So that some change is made on the blood in its descent depending upon the unusual length of the artery, and therefore we may admit a name applied by the ancients chiefly to the veins, calling them *vena prepurpurata*: we may conceive that the artery does prepare, or begin to make changes fit for the separation of the semen, before it reaches the gland.

CCCCI.

In next examining the vein, it bears an uncommon proportion to the artery. Perhaps some further use is to be derived from the numerous large veins favouring the return of the blood to the heart; and we observe from experience, that that vein is more apt to grow varicose than almost any other in the body. In some persons it is swelled to such a bulk as to stretch the skin of the scrotum; so it may be mistaken for a rupture, or other complaints; but if we apply the hand to

the scrotum, the swelling is unequal, and it gives a feel different from that of a hernial sac, or one filled with water.

CCCCI.

We distinguish a number of chords, and all of them soft, and we find the swelling running the whole length of the chord; and, in the horizontal position, it in a great measure subsides; and raising the body, the swelling gradually increases, and the blood enters the vein from beneath upwards. Tracing the minute branches, we find them entangled together; so they were thought uncommon anastomoses, but the injections keep their course; and we can give a general redness to the ducts within the testicle, and we find considerable arteries dividing minutely upon the seminal ducts.

CCCCII.

With regard to the seminal ducts, the bulk of the testicle is very much owing to a number of threads convoluted, which, from injection, we find to be hollow tubes. Measuring the size of these tubes, and examining the general bulk of the testicle, we find, that if the whole testicle were supposed to be formed of such tubes, the length would be nearly equal to 50,000 feet, or near to a mile in length. Now we cannot accurately determine how much of the real bulk depends upon the red blood circulating in the vessels, but

it is evident that much more than the one half of the bulk is owing to the feminal ducts, and the length of these is not less than 3000 feet in each testicle.

CCCCLIH.

The next point is the number of ducts entering into the composition of the testicle, which is not so very difficult to be determined as might be imagined; because in the testicle there is a structure that is altogether singular. We find a number of small ducts joining into larger ones in other glands, and therefore the duct continually increasing; but here the ducts run parallel to each other, without any anastomoses, or any division, or any gland or knot from which they are derived; so we need only attend to that end which communicates with the epididymis, and we can reckon 150 different ducts; and supposing that the mercury has not filled more than the half, there are 300 such tubes composing each of the testicles, so that each may be about 10 feet in length. These are every where convoluted in such a manner, that we trace the course with difficulty; and the blood vessels divide upon the surface, and perform the secretion in a particular manner. A coloured matter is even seen to pass from the artery into the tubes, though we fill ~~them~~ with the utmost difficulty.

CCCCLIV.

Now each of the tubes may be scarce the two hundredth part of an inch when filled with mercury, which increases their diameter nearly double; and we can trace the course of these ducts the whole way to the vesiculæ seminales. The division of these convoluted and serpentine tubes is not merely formed by blood vessels, but there are thin layers of the tunica propria, or albuginea, which slide in between, dividing one bundle from another, though not in a regular manner, as an orange is divided by septula. When these tubes run to the upper and back part of the testicle, they become straight; we find vasa recta that come out of them, and thence they communicate; or there is a rete testis, or the several ducts of the testicle that communicate just within the tunica albuginea adhering to it; and we find a number of vasa recta coming out, and conveying the semen into the epididymis, so called vasa efferentia, the number from twelve to fifteen or eighteen. After running a little way, they become convoluted. Now these coni vasculosi run also from the beginning of the epididymis, and after some time they all unite into a single tube; for, upon fixing a tube with mercury into the vas deferens, and cutting the epididymis transversely beyond the middle, the injection runs out from one orifice only; and upon separating the coni vasculosi, they

all unite into one duct. This at first is not larger than a single hair from a horse's tail, but gradually becomes wider, as we come near to the vas deferens; and it describes 20 feet at least before it terminates in the vas deferens.

CCCCLV. *

Thus after the semen is separated from the arteries, it acquires its properties in a great measure by stagnation and absorption, in passing through the seminal tubes; and we observe an uncommon number of lymphatic vesicles arising from the testicle.

CCCCCLVI.

One would be surpris'd to conceive by what power the semen can describe so long and intricate a course; and we must suppose that these tubes possess a truly muscular or living power. We cannot observe the contractions, or see the fibres; but the reason of the thing, and the observation that passions have been found to occasion swellings in the seminal ducts, lead to this supposition. In the dog kind the copulation is tedious, because the vesiculæ seminales are wanting; so the semen is brought round in that time from the testicle, and it must pass quicker than at other times, and there must be a living power to convey it, the vis a tergo assisting in some measure.

CCCCCLVII.

By attending to the situation of the epididymis,

we distinguish a swelling in the ducts from one in the testicle or *chord*. The principal part of the *chord* enters upon the inner side, and the epididymis is longer than the testicle, so that the bottom of it can be distinctly felt. We likewise see that the slightest wound of the epididymis beyond its middle may interrupt the course of the semen, so that a surgeon ought to be cautious not to puncture it in the smallest degree. Even if any swelling forms that can press upon a single turn of the duct, the whole organ above will be affected; and if it begins at the lower end of the epididymis, unless it is speedily removed, the whole epididymis and testicle will be affected. But considerable swellings often remain at the beginning of it, in the *coni vasculosi*, without affecting the testicle; because, from the communication at the *rete testis*, it passes into the *coni vasculosi*.

CCCCLVIII.

The *vas deferens* runs down at the back of the bladder, then ends in the *vesiculæ seminales*, in this manner: suppose the *intestinum cæcum*, the part of it pressed against each other, and that the *vas deferens* coming down against it, approaches nearer to the *vesiculæ seminales*, and is more convoluted; and add to the *intestinum cæcum* a number of *intestinula cæca*, several fæces containing the semen, and add the same to the *vas deferens*, the surface is greatly increased, with a

we are obliged to the question of the function of the prostate gland, in its liquors with the semen within the penis; but that is not so essential as the liquor in the testis; for in some classes of animals, as in birds, it is wanting, yet the structure of the testis is the same as in man, so it is only of secondary use. There is a quantity of mucus discharged for a defence against the water.

CCCCXV.

On the function of the penis, it depends on the blood, which is drawn down from the arteries, by their oscillations being increased. The common opinion is, that it depends upon a difficult return of the blood through the veins; and if the veins are tied up, the penis is in a certain degree distended.

CCCCXVI.

The only difficulty is to determine the means by which the stoppage is made, for that has been improperly explained, viz. that the vena ipsius penis runs on the clitoris, and that the muscles press it; but they rather draw down the penis, and make a pressure against the corpora cavernosa. The vena penis possesses a muscular, or contractile power, for it is redder and thicker than the other veins; and the principal plexus passes away from the artery in a very unusual manner within

the levatores ani, and is exposed to the action of these muscles, which are in action at the time, and some degree of contraction in the coats of the vesiculae feminales may assist in emptying them. The weight merely of the urine may dispose to the erection of the penis, and the blood being effused into the cells causes the distention.

CCCC LXI.

Female Parts of Generation.

The female parts of generation have commonly received, from anatomists, a division into external and internal, or those which appear to view on the mere exposure of the body; and those, again, which are more internal, and require a dissection of parts, and a more minute inspection to detect them. The former comprehends the mons veneris, the labia externa, nymphæ, and clitoris; the latter the vagina, the uterus, and its appendages.

CCCC LXII.

The mons veneris is the rising eminence we find situated at the termination of the recti muscles, or immediately above the next part, the labia externa. It is composed of a quantity of adipose substance, which forms the skin into a kind of tumour; and on this the first signs of puberty come to be conspicuous. It is through this part, also, an incision is directed in those cases where a division of the symphysis to enlarge the pubis by the operation of Sigault is made.

CCCCLXIII.

From its inferior part, on each side, arise the labia pudendi. In their texture, they resemble the mons veneris; and in their appearance a great variety prevail in different subjects. In some they are large and protuberant; in others, again, they are short and flaccid. Before parturition, however, they are generally shorter and more confined than afterwards, for they become lengthened by repeated labours; and in some cases also their fatty part decreasing, they become harder, and lose their sensibility. Their extent is mostly from the symphysis of the pubes to near the anus, a small space only termed the perinæum, or fourchette, intervening to form a division; yet, in particular cases, they have been found to extend to the anus itself. Internally, the membrane which lines them seems more condensed than the external, and is furnished with a number of small glands which excrete a sebaceous liquor for moistening their surface. By their softness they give no resistance to the passage of the child when so far advanced during labour; and, at the same time, they form a sufficient covering, by their junction, for defending from external injury the parts below.

CCCCLXIV.

On separating the labia appear two small fleshy bodies of a similar figure. They are termed the

nymphæ, and consist of a doubling of the internal membrane which lines the labia and the interior parts. They differ in their appearance in different women, and are of a texture very vascular, especially in their inner surface. Besides the purposes they serve in coition, their chief use seems to be to direct the flow of the urine, for they possess a muscular contraction at each time of its emission; though this is still more remarkable in some animals, as mares, in which also the labia have in some degree the same power. In girls, they discover somewhat of a corrugated appearance, and are very small; but after the age of puberty, or on the application of any stimulus to increase an afflux of their circulation, their size becomes enlarged. Hence they are fuller and more protuberant in prostitutes, and less so in modest women. This enlargement is sometimes preternatural, especially in hot climates, where an operation for their explanation, named nymphotomy, is therefore required.

CCCCLXV.

Immediately above the nymphæ, the latter being somewhat connected to its inferior part, is observable a small glandular substance. It consists chiefly of a congeries of vessels, covered by a loose skin, received from the internal membrane of the labia, termed its preputium; and this vascular part, or proper body of the clitoris,

takes its origin from the inferior part of the crura pubis, by means of two crura which unite here to form it. It has commonly been compared to the penis of the male, and in some respects, perhaps, resembles it. For, as it receives a more than usual quantity of blood above the parts described, it possesses also a greater degree of turgescence; and, from its sensibility, as its increase of fluid is easily produced by the application of any stimulus, it has become, in consequence of the latter, and by the dilatation of its vessels, frequently elongated to such a degree as to shew a similar erection. It differs, however, from the male penis in some particular circumstances, for it has no aperture or perforation for the transmission of any fluid, and consequently no corpora spongiosa, and it is tied down likewise by a kind of suspensory ligament, as has been apparent in those who have been shewn for herimophradites.

CCCCCLXVI.

Between the nymphæ there appears on their separation a hollow space, named the fossa navicularis, in the middle of which is observable a small prominence, or granulated point, being the orifice of the urinary passage, or urethra, in the female. It is larger than that in the male, and admits in diameter the size of a quill. Its whole length measures only about $1\frac{1}{2}$ inch from the bladder, which possesses at its neck no prostate

and, and forms the less resistance by this state of its parts to the passage of coëubi. By the profluence observed in its orifice, the urethra is easily distinguished by the feel; and round it there is situated a number of mucous glands, which secrete a liquor for defending the parts from the influence of the urinary acrimony, and these, as sores, being attacked by inflammation, acquire such a patulous flatness as to equal in diameter the size of the urethra itself; for which they are even sometimes in such instances mistaken.

CCCCCLXVII.

About two inches or less below the urethra, as described, by which its orifice is sometimes concealed in women who have born children, on separating the labia appears the first of the internal part, or the mouth of a large hollow tube, termed the vagina, which opening is called the os externum. It forms the entrance to the more interior parts, and is the passage through which the fetus is transmitted in delivery. Anteriorly, it is connected to the bladder, which is somewhat larger in the female, and more rounded in its shape than in the male; and posteriorly, to the rectum. Hence injuries happening here, are continued through these organs, and a passage for the urine and forces has thus frequently taken place for life from this situation. It consists of three coats. 1. A muscular, by means of which its fibres possess the

power of contraction, and therefore its dimensions vary at different times; and so strong is this muscular power which the vagina possesses, as frequently to throw instruments from their place when introduced for the purpose of delivery. *2dly*, A rugous; and *3dly*, an intermediate quantity of cellular substance. In its appearance, it is something similar to the membrane of the palate; for before parturition, or in young girls, it possesses on its internal surface a number of corrugated or wrinkled folds, termed its rugæ, which are placed in a transverse direction, in the form of an arch, so as to allow a greater enlargement of its diameter when expanded by the pressure of the foetal head in its expulsion to delivery. It is on this account, also, we find them most numerous on its anterior side, where it lies towards the urethra, and where the greatest degree of extension for the enlargement of its limits is required. Its length varies at different periods, and in the unimpregnated state it is generally three inches, though it depends for this on the situation of the uterus. After conception, the uterus falling lower, it becomes shorter. As the uterus, however, stretches upwards, it proportionally lengthens out the vagina; and, as its orifice projects loosely into its cavity, whatever cause relaxes the vagina, occasions its falling lower. The same variety prevails also in its width. At the age of puberty it is usually

so straight as hardly to admit a finger ; and in the first coition, therefore, the introduction of the penis becomes difficult. When conception in such circumstances takes place, labor is on this account tedious and difficult, and a long time is necessary for the stretching of the parts. After child-bearing, however, its dilatation becomes so great, as easily to admit the whole hand ; though, even in this state, from its contractile nature it can accommodate itself to the size of any exciting body introduced within its cavity. The degree of this contractility has been supposed by some to depend on its distance from the period of menstruation, by which the whole of the genital system is relaxed, and particularly the passages.

CCCCI.XVIII.

In its diameter, the vagina differs at different places ; for at its two extremities it is more contracted than in the middle. The os externum we find surrounded with a muscle whose fibres run in a circular direction, and serve, by this means, when excited into action, strongly to contract it. They take their rise from the ossa pubis, under the situation of the clitoris ; and, by this muscle, in those women who are advanced in life before the occurrence of pregnancy, a resistance to the passage of the head for the space of some hours is formed. In youth, also, in the first labour it becomes spasmodically constricted, and possesses

the same effect. On the internal surface of the vagina, besides the rugæ mentioned, we observe every where a number of small glands of the same nature with those round the orifice of the urethra, formerly described. They excrete a mucus most conspicuous in the time of coition and during labour, by which the effects of the stimulus attending both these operations is obviated, and the hazard of inflammation avoided. Its too copious discharge occurs also at times, and forms then a disease.

CCCCCLXIX.

But, besides the muscle serving to contract the os externum, and which is not so conspicuous, requiring a pretty accurate dissection, four small glandular bodies are observable of a simular shape, though somewhat different with respect to their particular figure: in different objects they are generally very regular in their appearance, termed the *carunculæ myrtiformes*. Many disputes have prevailed among authors with regard to their nature and uses. They seem partly much of the same kind with the *nymphæ*, being certain rugosities of the skin to allow the stretching of the parts when required. Though pretty distinct in the only part of life before parturition, they generally disappear like the rugæ of the vagina after childbirth, which further confirms our opinion of their use. Many, however, have supposed their struc-

AND DISSECTION.

ture glandular; and, if so, the particular offices they may serve by their excretion we are still at a loss to determine.

CCCCCLXX.

Instead of them, or as some affirm, previous to their appearance in the infantine state, we find a thin membrane in the form of a crescent extended partly over the orifice of the vagina, named the hymen. No subject has, perhaps, been more disputed by anatomists than the existence of this part, and we have the authority of the late Dr. Hunter for declaring that it is never absent in a female at birth. From its texture, however, it is easily ruptured by accidental causes in childhood, and then assumes the appearance of the carunculae myrtiformes. In some cases it has been known to continue, however, entire to the age of puberty, and to extend further over the os externum than usual. In such cases an incision has been found necessary for its removal.

CCCCCLXXI.

The parts of the genital system, as yet examined, may be considered only with regard to generation in a secondary view; and we are next, therefore, in our examination directed to those organs which are more interiorly situated, and with which generation itself is more immediately connected.

CCCCCLXXII.

The first of these, at the extremity of the

vagina, is the uterus. It is situated in the middle of the pelvis, between the bladder on its anterior part, and the rectum posteriorly; and hence, in consequence of disease, a communication with both these, as in the case of the vagina before mentioned, may be occasionally produced. In its natural state its figure has been compared to a pear flattened on its sides, or to a small powder flask; and by this flatness on its sides, which is most remarkable posteriorly, where it joins the rectum, it comes to be more closely retained in its situation, or applied to the neighbouring parts. Anatomists have commonly described it under three divisions, or distinct parts; the superior and largest one bounded by the Fallopian tubes, being termed its fundus; next to this its body, and its inferior portion ending in its orifice, named the cervix or collum. At both its extremities the uterus is a little convex, and at its fundus this convexity is increased in the pregnant state, by which, when distended, and rising above the pelvis, as we shall afterwards find, it forms something of an arch, and becomes more capable of supporting the incumbent viscera. Its size has been commonly supposed to measure longitudinally, beginning from its fundus to its orifice, three inches; and transversely, from two to one, according to the distance at which we take it from the fundus. After the age of 14, or the

appearance of the menses, it does not seem to increase, and in this it differs from the other organs of the body. Some small difference, however, may be perceived at each successive period of this discharge, for before the evacuation, the fundus may sometimes be felt in thin women by the hand applied on the abdomen, tense and more than usually distended; and those also, who are subject to profuse menstruation, from the greater dilatation of its vessels, have the uterus considerably more enlarged than the others. Some authors deny that the uterus, internally, before impregnation possesses any sensible cavity. It is, indeed, small, but when cut open, will be found very apparent. Its figure is triangular, two angles of which arise from the orifices of the Fallopian tubes, and the third from the os tincæ. Through its whole substance the uterus seems, on dissection, to possess a very compact nature, which has been compared, from the whiteness of its texture in the virgin state, to the corpora spongiosa penis. Externally, it receives a covering from the peritonæum, and this covering forms the means by which it is connected to the Fallopian tubes and ovaria, while internally, again, the fine membrane lining the vagina, is continued over its surface, and hence it possesses here the same glandular texture with that of the vagina described. Before pregnancy, it is even distin-

guished by the firm rugous appearance; and these rugæ are most numerous at its neck, where, after parturition, some traces of them in young subjects still remain. In the neck, also, are conspicuous a number of small lacunæ, or ducts, which pour out a mucus for lubricating the adjacent parts of its cavity, and which form a cement, closing the orifice of the uterus during gestation. From our experience of its contractile power in labour, by the expulsion of the child we are naturally led to suppose the uterus a muscular organ. Its muscular fibres, however, till after delivery, it is difficult to distinguish, and then they appear to be matted together irregularly, so that there is no proper foundation for the musculus orbicularis painted by Ruysch. These muscular fibres, when perceptible, are most so on its external surface, which is less firm than the internal, and the latter again than the cervix. In proportion to its size, the uterus receives a greater quantity of blood than any other organ, the heart and lungs excepted, and its vessels are therefore, even in the natural state, proportionally large. They are derived from the hypogastrics and spermatics, those from the latter being smallest, and are spread in a tortuous convoluted manner through its substance. The vein, however, are still larger than the arteries, and are derived also from the same source. They have no valves, and by this means

the motion of their fluids is rendered slower, and a degree of stagnation favoured, while frequently anastomosing in particular places, they acquire in this way a remarkable size, and are therefore distinguished in pregnancy by the name of sinuses.

CCCCCLXXIII.

The nerves of the uterus are derived from branches of the 6th pair, or that one which supplies the stomach and some of the other viscera. It receives them likewise from those of the sacrum, and hence the remarkable sympathy, in cases of disease, it communicates to all these parts. The situation of the uterus, we mentioned as in the middle of the pelvis, above which it is not to be felt in the unimpregnated state; for a line drawn from the top of the sacrum to the pelvis, will hardly fall within its fundus: but before the age of puberty it is generally found higher, being, in consequence of the pressure of the intestines and its attachment with the bladder of urine, made gradually to sink lower; and after conception it comes again to be raised, to as, at the end of gestation, to reach as high as the pit of the stomach. It is not placed perpendicularly, but a little to one side, and that commonly the left, which we find very apparent in pregnancy. The neck of the uterus projects, as we observed, into the vagina, and that in young subjects, in

the form of a nipple or small tubercle. After parturition it becomes in its figure more elliptic; and in those who have born many children, the finger may be introduced within its orifice for a little way. We find a vast difference between the structure of the uterus in animals, when compared with that of the human subject. In them it is separated into certain divisions, or cells, for the reception of each foetus, not possessing a uniform cavity like that described, and these cells have not the smallest connection. Its internal substance is likewise unequal at particular places, by certain glandular bodies growing from its substance, named cottilydons, and which serve, by being connected with the foetus, to nourish it in the pregnant state. The uterus is preserved in its situation by four ligamentous expansions, or productions from its external covering. The first are named the ligamenta lata, and are connected to the bones of the ilium, so as to retain it in its proper length; and the latter, running off from the former in the form of cylindrical chords, from their figure are named the rotunda, and pass through the groin, in the same place as the spermatics in men, confining it before. Both are lessened in their size by their extension during pregnancy, and especially the round ones. Their situation is also somewhat altered, during the same period; for, by the enlargement of the

fundus, the broad ones are placed in a situation much below the middle of the uterus, which they formerly possessed; while the uterus itself is less fixed, the greater part of its body floating loose in the abdomen; and an inversion of it, on this account, is more readily endangered after delivery. The round ones have, by many, been supposed to act in a certain degree as muscles to the uterus, by drawing the fundus a little downwards, and consequently lowering its orifice for the more easy admission of the semen in coition, and the descent of the child's head in labour. In the latter case, it seems to prevail in a first labour, when the fundus rises higher than afterwards, and where, of course, they are put more upon the stretch. The ligamenta lata have no remarkable circumstances to distinguish them, except from forming also a covering to the Fallopian tubes and ovaria. Where that part of the uterus, named its fundus, ends, are observable two small orifices, fit only to receive the size of a hog's bristle, and which enlarge in width, in the manner of a trumpet, as the cavity of their passage ascends, terminating at last in a sort of ragged or fringed appearance, which is loose and floating, named the *morus diaboli*, and is somewhat similar in its figure to the foot of a frog when expanded. These passages are termed, from the name of their discoverer, the Fallopian tubes; and merit our

particular attention, as on their state, along with that of the ovaria, the occurrence of conception has been supposed to depend. Their cavity proceeds not in a straight, but convoluted direction, measuring near three inches in length, and their texture seems evidently of a muscular nature, though its fibres, from their minuteness, it is difficult to unravel. They are connected to the ovaria, or two oblong bodies, by means of their covering or external coat, and in this connection they show some resemblance to that of the intestines with the mesentery.

CCCCCLXXIV.

The ovaria are two oblong soft bodies, situated beside the Fallopian tubes, and so named by physiologists from their containing, on dissection, a number of small vesicles, or limpid bags. They have been commonly compared in their appearance to the testicles, and supposed as designed for a similar function, and hence is derived the opinion of the semen in the female. Their figure is somewhat different in different women. In their size, however, they are pretty much the same, though after childbearing they turn more flaccid and decayed; and their state has been supposed in a great measure to influence the other parts of the genital system. Their dimensions are commonly rated at 1. inch in length, $\frac{1}{2}$ in breadth, $\frac{1}{4}$ in thickness, and their texture seems very vascular, while their sur-

face externally is very unequal. The number of ova contained in them is very various. These ova form the rudiments of the future foetus, an opinion fully established by the experiments of many modern physiologists.

CCCCLXXV.

In reviewing the genital parts of the female, we observe no holes naturally leading out from the ovarium, and yet afterwards it will appear, beyond all doubt, that the ova discharge themselves upon the surface; for the chord which ties the ovarium to the uterus is solid, and is not, as was supposed, a tube serving for conveyance; it is merely a ligament; and the only passage we find between the ovarium and uterus, is through the tube named uterine, or, after its inventor, Fallopian. The mouth of this is wide, more than sufficient to contain an entire vesicle from the ovarium; but then, as it approaches the uterus, it becomes much smaller, only admitting a large bristle. Around the mouth, which opens into the cavity of the pelvis, or abdomen, we find a number of fimbriae, or fringes; and although these serve one uniform purpose of laying hold of the ovarium, as we lay hold of any substance by the hand, yet it is found that the fimbriae vary in their shape in every subject. Their structure, and that of the rest of the tube, is, without all doubt, muscular; we distinguish red fibres, that are laid

parallel to one another, we have the same evidence of muscular structure here that we can give in describing the parts of the alimentary canal. The uterine tube terminates at the corner of the uterus, serving to convey the rudiments of the fœtus into it. We avoid determining the appearance of the rudiments more exactly; nor do we say that one entire ovum passes, but merely a somewhat is conveyed.

CCCCCLXXVI.

The uterus is spongy in its inner part, and is full of vessels with orifices, from which blood is discharged into the cavity of the uterus at every menstrual period. The cavity of the uterus becomes gradually of a roundish shape, and forms the cervix uteri, and this part we have seen unequal, with a number of rugæ or valves, and in these interstices a quantity of slime is deposited, and the texture is different from the rest of the body of the uterus. The end of the cervix uteri, or os tincæ, is directed backwards, and rests against the vagina, and it is kept in this situation by the manner in which the uterus and its appendices is supported by the ligamenta lata, which are doublings of the peritonæum, the same as the mesentery is. To shew the advantage of this situation, it may be remarked, that the ligamentum latum, by the distension of the uterus, is gradually lessened in its breadth, till in the last

months of pregnancy we scarcely can show it; so that it does not merely support the uterus in the unimpregnated state, but is so formed, that the outer covering may yield in proportion to its growth, and the lamellæ are gradually separated from each other to keep the uterus more steadily in its place. We also find the ligamenta rotunda, which serve to balance the uterus, to keep it from being tossed from side to side, and they also drag the body of the uterus forwards, and therefore serve to keep the os tincæ more in the direction backwards, and thus the uterus is turned more backwards in the time of pregnancy than it is at other times, when there is more occasion for preventing its falling down into the vagina. The vagina in pressing downwards, is likewise not a straight direction, but resembling the intestinum rectum, at the lower part turns forwards, and that still in a greater degree. Within the vagina we find organs for secreting mucus, and at the external part, cells that are capable of distension, containing the corpora cavernosa. On the manner of their distension it may be said that the external parts, by their sensibility, serve to excite these motions of the internal, which are necessary for conception, particularly of the uterine tubes towards the ovaria, and afterwards in promoting the somewhat into the cavity of the uterus. From attending to the connection and situation of these parts,

we can understand several things that happen in practice.

CCCCXXVII.

First, without entering into the reason of it, it is a fact that neighbouring parts sympathize or suffer together. Thus, if the middle finger has been bruised, and inflames, the one next it more readily partakes of the inflammation than a more distant part. So in practice we find that an irritation being applied to the bladder, uterus, or rectum, the affection is propagated from the one to the other. Thus the menstrual flux can be retarded by an irritation begun in the bladder or rectum, and the bladder will sympathize, and a stranguy be occasioned by an affection of the uterus or vagina. We can also conceive that the mechanical connection of the parts must have a very considerable effect, for the bottom of the bladder is connected closely to the vagina, not only the urethra being connected, but likewise the body of the bladder, and that higher than the mouth of the urethra, and we may make an application of this in several cases. Thus, if there should be a prolapsus uteri into the vagina, it must necessarily drag along with it the under and back part of the bladder, and likewise affect the intestinum rectum, though there is here a less connection, from mere cellular substance being interposed. Remarkable cases have occurred where

The prolapsu uteri has been to such a degree, that the uterus has fallen without the body, the os tinct forming the lowermost part of a tumour reaching between the thigh, and the back of the bladder has been dragged along with it, so as to invert the urethra, so that the urine has had to ascend in order to get out, and the bladder been so much distended, that it reached higher than the umbilicus, and was capable of containing six or eight parts of liquor, with which the coats were much thickened. The bladder may be supposed to affect the uterus; so, if a stone in the bladder proves an irritation as frequently to cause the prolapsus ani, which is by no means uncommon, it may have a similar effect upon the uterus and vagina.

CCCCCLXXVIII.

The mere distension of the parts here preserving their natural place must have a very considerable effect, hence it is a rule laid down by writers in midwifery to empty the bladder and rectum before delivery. And we can explain why in one stage of pregnancy a woman will not be able to retain the usual quantity of water, from the uterus pressing upon the bladder: but in another situation the weight of the uterus bearing down upon the urethra, and compressing it against the os pubis, there may be a necessity for drawing off the water with a catheter, or a costiveness may be induced from the same cause. We also see the danger

there may be of fistulæ forming between the bladder and vagina in consequence of a violent inflammation from a laborious delivery, &c. Many examples occur where the urine has made its way through at the cervix of the bladder into the vagina, and it is found impracticable to cure the patients by any operation. From other causes, as in cancerous cases, we find also erosions and communications between the vagina and intestinum rectum.

CCCCCLXXIX.

If there were a necessity for making a large opening into the cavity of the uterus for extracting a child, the danger of that would be considerable, from the whole body of the uterus being covered with the peritonæum. If water were collected in order to avoid this circumstance, we would attempt to make the discharge by making a puncture through the cervix uteri. The ovaria are frequently the seat of dropical complaints, and the water is, no doubt, contained in the natural cyst, which are sometimes considerably enlarged, to the bulk of an egg; and if these are small and moveable, we cannot let out the water without the most manifest danger; and we can only attempt it when, by pressing against the containing parts, they cause an inflammation and adhesion.

CCCCLXXX.

Next, is seen the ureter going into the bladder between it and the vagina; and it is of use to attend to this, for cases have occurred, where a stone has descended as far as the bladder from the kidney, but sticking in the ureter, stopped the flow of the urine, and killed the patient. Now, if we can judge this to be the complaint, we may feel with the finger, and we will be able to perceive the stone through the coat of the ureter; and, perhaps, by the finger, or an instrument, we may get it back into the bladder; or, it is possible to make an incision without any danger, but the opening remaining fistulous into the vagina, and this might not even continue. Or, if a stone lies within the body of the bladder, we can not only perform the high operation with more safety than in the male, the bladder even when moderately filled, lying a good way above the os pubis, from the great capacity of the vagina; but we can get from the vagina into the bladder without hurting any of the vessels, or nerves, of considerable moment. But that this is the last mode of operation, we do not say, because of the possibility of it. But it is the most successful operation, where a stone is in the body of the bladder, has irritated the wall, and produced ulceration, making a

way into the vagina. If, in the male, we prefer the lateral operation to any other, there is further reason for preferring it here, where there is wanting the prostate glands and vesiculæ feminales. Likewise we can, as in the male, make the puncture into the bladder between the crus of clitoris, or side of the vagina; or it may be done directly from the vagina, passing an instrument at pleasure near to, or further from, the neck of the bladder.

CCCCCLXXXI.

The description of the gravid uterus, and the changes induced by conception, are detailed in the Clinical Guide, Vol. III. Midwifery.

CCCCCLXXXII.

Chemical Analysis of the Secretion of the Parts of Generation.

The mucus of the urethra differs in no respect from the mucus elsewhere, and under irritation it is increased in quantity, and changed in consistence in a considerable degree.

The secretion of the glans penis is of a sebaceous consistence, and it possesses a peculiar odor, the organ of it being lined by some odoriferous glands; and, like the other secretions, it is considerably increased under irritation, and when a necessity exists for its use.

The tunica vaginalis of the testicle possesses an aqueous exhalation to admit the free motion of the organ, which is often considerably increased under disease.

The prostate gland secretes a lactescent juice, which being emitted always along with the semen, must be necessary to the perfection of that fluid.

But the most important secretion of these parts is the semen, which is also the most highly elaborated of any in the body. In taste, it is fatuous and acrid. In consistence, it varies according to the progress of its course, being thinner in the testicles, and viscid, dense, and pellucid in the vesiculæ seminales; but debility and relaxation produce a change in its quality. In colour, also, it varies a little in different parts of its progress, being of a deeper hue in the vesicles than in the testicles.

Its constituent principles are ;

1. Water, 90 parts.
2. Animal mucilage, 6 parts.
3. Phosphate of lime, and muriate of soda, each one part.
4. Pure soda, 3 parts.
5. An animalcular appearance ; and,
6. An odorous principle, or aura seminis.

It changes violets green. When fresh, it is insoluble in water, but afterwards combines easily with it. It is at first opaque and consistent, but in a few hours becomes clear and pellucid, and in a few days deposits foliated crystals of phosphate of lime. Its uses and importance in the system are well known.

Chemical Analysis of the Secretions of the Female Parts.

The **unfluorid** fluid of the inner surface of the labia pudendi is of a mucous oily consistence, of a yellowish colour, and peculiar offensive smell. It consists of an

oily mucus, mixed with a peculiar odorous principle, which probably stimulates to venery.

The mucus of the vagina is of a viscous nature, and most abundant towards the end of pregnancy, and in parturition.

The excretion of the venereal organism is a whitish mucus, somewhat different from the common secretion of the vagina. Its quantity is very great in the fallacious.

The uterine secretion, or serous discharge, is in virgins turbid and whitish, in children always so, and in pregnant women it is sometimes lactescent. Its quantity varies at different times.

The mucus of the uterine cervix is very thick during pregnancy, and sometimes of a reddish colour.

The liquor of the ovarium appears to be albuminous, coagulable by alcohol and fire, and ductile into white threads.

The menstrual and lactical discharges differ nothing from common blood, already examined.

Anatomical Preparation of the Penis.

To make an injection, an adult penis is preferred, which should be removed from the body for the greater ease of the process. The knife, in doing it, being carried close to the pelvis, so as to avoid wounding the crura, and carried towards the bladder so as to separate it by a transverse incision just before the prostate. For this purpose a section of the scrotum should be made to allow its complete removal. The blood in the corpora cavernosa is then to be washed out by first fixing a middle sized injection pipe in one of the crura through

a small incision purposely made, and then injecting warm water afterwards, pour'd out and repeated so long as it shows a bloody tinge. The orifice of the large vein on the back of the penis is then to be found in the groove formed by it *leptum*, and a probe introduced into it as far as the glands, in order to break down its valves, which would obstruct the progress of the injection. A pipe is then to be fixed in it, and warm water injected to clear it from gumous blood, and again press'd out. Let it then be prepared for injection by immersing it for an hour in warm water, and the corpora cavernosa are then to be fill'd with coarse yellow injection, and the vena magna, glands, and long body, with red. The teguments being afterwards dissected from it, the preparation is to be dried and varnished, or preserved in spirits of wine.

Anatomical Preparation of the Testicles.

The testicles are to be removed from the body, and the spermatic cord is to be separated as high as possible without wounding it. The artery should be fill'd with fine and coarse red injection, and the vein with coarse yellow. The vas deferens should be always fill'd with quicksilver; for, from its length and smallness, it cannot be fill'd with any other injection, and in doing it considerable time is required from its convolutions. It should remain for some time under water in the injecting tube, that the injection may pass as far as possible by its own weight, and the injection of this part should follow that of the other vessels. The ends of all the vessels are then to be tied, and next the surrounding extraneous substance dissected away. The preparation

is then to be laid in water for some days to extract the blood, and brighten its colour, after which it is to be suspended in the air till the parts dry, and then be preserved in oil of turpentine. In making this preparation, all the vessels should be previously well cleared from blood.

Preparation of the Internal Structure of the Penis.

Where the internal structure of the penis is wished to be shewn, its arteries are first to be injected by coarse red, fixing the pipe for this purpose on each side in the internal pudendal artery, on the inner side of the ischium. The penis is then to be removed, and injected as already directed, but with quicksilver entirely. It is then to be macerated in water till the cuticle peels off, and suspended in the air till thoroughly dried. With a knife, two lateral portions are then to be removed from the glans to the crura, which will lay open its internal parts. Two lateral pieces are also to be removed from the glans. These openings giving an exit to the quicksilver, will better shew the internal structure. Immersed in oil of turpentine, the preparation will become transparent, and exhibit the ramifications of the vessels through the corpora cavernosa.

Corroded Preparation of the Penis.

This preparation is injected, as directed in the first. When finished, the part is to be put in the muriatic acid solution till the parts are fully destroyed. When removed from the acid, it is to be washed as other corrosions, and caution used not to break any of the vascular branches.

CCCCLXXXIII.

Circulation of the Pelvis and the Lower Extremity.

Having examined the genital system in both sexes, it remains to trace the circulation and nerves of the pelvis, from thence proceeding to the lower extremities.

CCCCLXXXIV.

The lumbar arteries, four in number, on each side arise in pairs from the back of the abdominal aorta, and resemble the intercostals in this respect as they arise in the thorax. They run over the fore part of the lumbar vertebræ, and, descending, they give branches to the spine and spinal marrow; and, being dispersed upon the lumbar muscles, they also furnish branches to the teguments. Next, the sacral artery, running along the middle of this bone, gives circulation to the bones, membranes, and back part of the rectum.

CCCCLXXXV.

The common iliacs arise from a division of the aorta at the 4th lumbar vertebra. They are of equal size, and at the last vertebra of the loins they each divide into two branches, an anterior and posterior one, or the external and internal iliac artery.

CCCCLXXXVI.

The external iliac, or continuation of the common trunk, descends along the brim of the pelvis, takes a curved direction by the side of the psoas

muscle, and passing behind Poupart's ligament, goes to form the femoral artery. Within the abdomen it sends off two branches, the epigastric and circumflex of the navel.

CCCCLXXXVII.

The internal iliac is chiefly distributed on the pelvis, and gives branches to all the parts contained within it, and which branches chiefly take their names from the parts they supply, and are very numerous. Thus they give the chief branches to the bladder and penis, and also to the uterus and genital parts of females.

CCCCLXXXVIII.

The circulation of the lower extremity again begins with the crural or femoral artery, which, about two fingers' breadth below Poupart's ligament, divides, like the common iliac, into an anterior and posterior branch, the former continuing, as the proper femoral artery; the latter, being termed the profunda femoris, which sends off branches to all the adjacent parts in the progress of its descent. The femoral artery again passes between the triceps muscle and the bone, to which it keeps close till it reaches the ham, and is there termed the popliteal artery. Passing between the condyles of the os femoris, it gives off several branches to the joint, and next to the upper part of the leg; then descending, it gives off to the outer edge of the popliteus two large arteries, the

tibialis antica and postica, the former supplying the fore, the latter the posterior part of the leg. These tibial arteries, in their progress, give off numerous branches. At the ankle they send off the principal plantar branches, and these again subdivide into the interosseous and digital arteries.

These arteries of the foot freely communicate with each other and form anastomoses, so as to preserve a full and free circulation of these parts.

CCCCCLXXXIX.

The veins of the inferior extremity consist of a subcutaneous and deep set. The former consist of two principal trunks, the saphenæ; the latter are more numerous, and correspond to the arteries in their course and names. They all end in the iliaca communes, which unite to form the inferior cava, which exceeds in size that of the superior, and receives, at its beginning, the sacral and lumbar veins, which in the left side pass behind the trunk of the aorta.

CCCCXC.

Nerves of the Pelvis and the Lower Extremity.

From the nerves formerly described of the chylopoetic viscera, we descend to the hypogastric plexus, which is connected to the great sympathetic and sacral nerves, and sends small twigs to the bladder, rectum, and spermatic vessels in the male; and to the same parts, and the uterus and vagina in the female. The great sympathetic

runs along with the lumbar and sacral nerves, and supplies the loins, pelvis, and inferior extremity.

CCCCXCI.

In doing this, the sympathetic nerve from the lumbar vertebræ descends into the pelvis, and passes over the anterior surface of the os sacrum. At the lower part of the pelvis it becomes smaller, finishing its course on the coccyx. In the loins and pelvis it forms ganglia, which, in the latter, are connected with the sacral nerves.

CCCCXCII.

The five lumbar nerves in their descent form a plexus, which is situated behind the psoas muscle, and termed the lumbar plexus. In their farther progress these nerves unite, and form a trunk of great size, named the crural, which sends down branches to every part of the leg.

CCCCXCIII.

The sacral nerves consist of small posterior, and large anterior trunks. They go out of the holes in the forepart of the sacrum, and unite with each other, and with branches of the sympathetic. They afterwards in part join with some of the lumbar, and form a plexus which gives origin to the sciatic nerve, the largest in the body. The roots of the sciatic form the fasciculi, from whence arises the pudic nerve. The sciatic nerve, after leaving the pelvis, descends in the back part of

the thigh to the ham, where it receives the name of the popliteal nerve, and in this course it gives off a great number of branches. A little above the bending of the knee it is divided into the tibial and fibular nerve, which possess also their subdivisions. In the end, the tibial nerve divides into the external and internal plantar of the foot, which are distributed as the principal supply of the sole and toes.

CCCCXCIV.

We now come to consider the vascular distribution of the inferior extremities in review. The trunk of the aorta within the abdomen is close to the spine, hence the swelling and stroke of it are entirely outwards; so that in many persons the containing parts of the abdomen being pressed backwards, we can distinguish the stroke; and sometimes persons have been supposed to labour under aneurism of the aorta from this circumstance.

CCCCXCV.

About the fourth lumbar vertebra the aorta divides into two equal branches, for there is nothing found in the distribution of the vessels which should determine us to prefer one extremity to the other. And, in fact, if by any accident the right arm comes to be disabled, persons very readily learn to give the left leg the preference in performing the motions; and this

may serve to confirm the reason of the preference mankind in general give to the right arm, that the particular division of the aorta has a sensible effect. The aorta runs outwards not in a direct line to the thigh, but in order to avoid the cavity of the pelvis a considerable angle is formed, and the blood rushes against the division with considerable force; and this may explain what we find, that, next after the beginning of the aorta from the heart, the division of it at the iliacs is most subject to disease.

CCCCXCVI.

Here we can judge of the proportion which branches bear to the trunk; and from this division we would suppose that the common computation made is nearly just, that the branches put together exceed the trunk by one half.

CCCCXCVII.

The principal artery of the uterus is the hypogastric, and from its situation an experiment has been proposed, to make pressure on the femoral artery, in order to promote the menstrual discharge; and though we are not to expect so much as has been imagined from this, because we do not find that a sudden increase of the force of the blood always causes the menstrual discharge; yet that may be supposed to concur, whilst other circumstances are favourable, and therefore in many cases the experiment ought to be pursued.

It is evident that the pressure upon this artery must increase the momentum of the blood in the uterus, and in many cases at least promote the discharge.

CCCCXCVIII.

In both sexes we see a branch spent upon the middle of the intestinum rectum, whilst other branches are furnished to the extremity of the rectum. Now it is evident, that the common account of the cause and frequency of hæmorrhoids is by no means just, that the blood returns difficultly through the vena portarum, for their most common seat is supplied from the aorta, and the blood is returned by the vena cava; so we must find some other cause. In a few cases, the discharge, perhaps, is made higher; and the difficulty of the return through the vena portarum may render the discharge more copious.

CCCCXCIX.

A branch descends from the internal to the external organs of generation, and the situation of the artery with respect to its vein is particular, the elevator coming in between them; hence the erection of the penis is in a great measure owing to the action of that muscle, and the same applies to the female.

D.

The last branch of the internal iliac supplies the musculi glutæi. An aneurism is sometimes formed

under the glutæus maximus, occupying the back of the great trochanter. An aneurism may remain long in the same situation, and therefore we should not be too rash in forming a prognosis.

DI.

The external artery is lodged at the side of the psoas muscle, protected as much as possible from the pressure of the bowels in the pelvis and abdomen; and the artery here runs external to the vein, perhaps because the artery suffers less from pressure than the vein would have done. We sometimes see, from the effect of the pressure, œdematous swellings produced in the legs.

DII.

The artery at length gets behind the tendon of the oblique, and sends off two considerable branches, the circumflex artery, and the epigastric artery. We find the latter covered by the inguinal glands, to which it is tied by cellular substance; and, therefore, in treating these by operation, we should be particularly cautious; even caustic laid along, might go so deep as to reach the coats of the artery; and therefore it is safest to treat buboes, &c. by incision.

DIII.

At this place the artery is situated directly over the head of the thigh bone, covering the round ball. Hence surgeons have been deterred from making incisions into the cavity of the joint to

discharge matter, &c.; and it is certain that an incision cannot be made into a joint or ligament without a considerable degree of danger, yet the danger from the effect the matter has upon the ligaments, inflaming them, producing hectic symptoms, &c.: or, from its making its way into the pelvis through the socket, &c. may be greater, especially as we can make the incision without wounding the arteries or nerves, as the capsular ligament of the thigh does not merely include the ball, but takes in the neck of the thigh bone; so we can make the incision at the outside of the beginning of the sartorius muscle; and of the tendon of the iliacus internus, at the most depending place, where the matter will be most readily discharged. Lower than this, it gives off its circumflex branches which communicate with the internal iliacus; and if, by any accident, the femoral artery should be wounded, we may not only save the life, but the limb, and are not to think of amputating at the top of the thigh, which, from the quantity of blood lost, the number of nerves, &c. is attended with the utmost danger; so we must attempt to tie the artery, in the hopes that the branches may convey as much blood as is necessary; and going lower, the prospect of success continually increases, because of the more numerous anastomoses.

DIV.

As the artery passes downwards to the ham, it lies near to the bone, so we can stop the blood with a tourniquet, by pressing the femoral artery against the bone.

DV.

We attend to the exact situation of the arteries, in order to find them after an amputation. There is no difficulty of finding the trunk of the femoral one in the thigh; but in the leg, two of the arteries are more connected to membranes; the anterior tibial is connected to the interosseous membrane in such a manner, that it requires attention to detach it. The difficulty of raising this is such, that the surgeon sometimes ties the thread round the bone; but that includes the periosteum, and several threads of the muscles. And as the nerves are divided here minutely, some of the membranes may be taken in.

DVI.

When we trace back the blood from the foot, we observe the same general structure as in the arm; only the deep-seated veins are larger, and the outer ones of course smaller. From the greater activity of the superior extremity performing more varied motions, so the blood is more in danger of being stopped, and the deep veins do not divide into so many branches; but they are larger, and therefore a surgeon in performing

amputation will be under the necessity of tying the veins, as well as the arteries, if the amputation is immediately above a pair of valves, the neighbouring veins pouring in their blood.

DVII.

The last general remark upon the blood vessels here is, that the coats, both of the arteries and veins, are remarkably thicker than in any other place of the body; and from this we may conclude, that the force of the heart is not so very immense as many physiologists have supposed, otherwise the addition of a few feet of column would not have made so great a difference. We see the effect of the column in dropical swellings more readily appearing in the feet; and we can account for that, without supposing that the branches of the red veins absorb, for there is a greater pressure made upon the lateral branches of the arteries, and the swelling may be owing, not to a want of absorption, but to an increased exhalation; and taking in the lymphatic system, we see that the absorbed liquors return more difficultly.

DVIII.

But notwithstanding of the increase of the thickness of the coats, the veins of the lower extremities are more subject to varix than the upper, for they are subject to more unequal pressure; they are acted upon by many muscles before

the blood returns to the heart, and the pressure made by the contents of the abdomen is very unequal, even a pressure made by dress will have the same effect as a distention of the bowels in the abdomen.

DIX.

To conclude our account of the vessels and nerves of the inferior extremities, the anterior branches of the nerves are by much the largest, particularly in the trunk of the body: the muscles are supplied by a number of minute branches, none of which are of such consequences as to prevent a surgical operation: and every one of the long muscles is supplied from a number of nerves; and, instead of flexion being performed by one nerve, and extension by means of a different nerve, we see them supplied by the same nerve, and a single flexor or extensor supplied from a number of roots.

DX.

When a stone descends through the ureter, crossing obliquely the anterior branches of the nerves in the loins, the cremaster muscle is thrown into action, and drawn upwards. We are not to suppose that the ureter can make mechanical pressure upon these nerves. But, first, an irritation is communicated to the neighbouring parts, an inflammation is excited, and suppose the hydraulic system detached from the nervous, we

should not observe any contraction of the cremaster; it is from an inflammation spreading more readily to the neighbouring organs: and the bending of the body forwards, which takes place in an inflammation of the psoas muscle, chiefly proceeds from the ease the patient finds in that posture by the parts being relaxed, and not that the muscle is in a spasmodic and convulsive action, for the patient can, though with difficulty and pain, extend the body behind the psoas.

DXI.

In the small nerves of the extremity those are to be avoided carefully that run upon the sides of the sheaths of the tendons.

DXII.

Anatomical Preparation of the Extremities.

The superior extremities are to be removed from the trunk. The clavicle is raised for this purpose, and the knife past under the articulation, so as to include the greater part of the pectoral muscle; and, by directing it under the scapula, the clavicle, scapula, and subscapularis muscle will also be removed. A pipe is then to be fixed in the axillary artery, which becomes divided by the separation of the parts, and another pipe is to be inserted in one of the veins on the back of the hand; and having previously washed out the blood from the veins, the injection is to be conducted in the usual manner, preventing its passing out in the time of the operation from the axillary vein, over which a loose ligature should be thrown.

The lower extremities are to be removed by opening the abdomen, and removing its contents, or placing them out of the way. A section is then to be made through the symphysis pubis and its ligaments, and next through the ilium and sacrum, so that along with the extremities one side of the pelvis may be removed. In injecting, the pipes are then to be fixed, one in the iliac artery, and the other in one of the large veins of the foot, as near as possible to the toes. The preparation is then to be finished in the usual manner.

Anatomical Preparation of the Hand.

An old emaciated female hand is the one preferable for this purpose. The forearm is to be separated by a transverse section above the wrist, and the steel pipe fixed in the radial artery with a ligature. The quick-silver being poured into the tube, will soon fill all the vessels, and begin to flow out where the section is made, and will thus remove any coagula. The vessels are next to be secured, first catching them by the forceps, and applying a ligature over each, first over the arteries, and then over the veins. If not sufficient, a general ligature, as a tourniquet, may be applied over the arm. When the vessels are thus secured, the preparation is to be suspended in water for a day without removing the pipe or ligature. The latter are then to be removed. Putrefaction is to be allowed to take place till the cuticle peels off, when the part is to be suspended in the air to dry, and when dry carefully varnished. By such preparations a beautiful display of the vessels is afforded.

DXIII.

Lymphatic Vessels.

To finish the description of the vascular parts, one set of vessels, or the appendages of the thoracic duct still remain, termed the lacteals and lymphatics, universally distributed over the body.

. DXIV.

These vessels are small pellucid tubes, which begin by numberless open mouths, visible only by the assistance of glasses, arising every where from the surfaces, both external and internal. They stem every where to run in two sets; a superficial one, the branches of which are most numerous; and a deeper one accompanying the arteries, and in a double proportion at least to the latter. They are termed lacteals on the inside of the intestines from the white liquor or chyle they contain, and they are termed lymphatics wherever they are not filled by this fluid.

DXV.

Their general termination is in the thoracic duct, already described, and in no other parts of the venous system do they appear to terminate.

DXVI.

The texture of the absorbents seems stronger than that of the red veins, though it is too minute for a particular examination. Their muscular power is apparent from their action, and by this power are their contents conveyed from their origin

to the thoracic duct, and urged on also by the motion of the surrounding parts. They are furnished also with blood vessels and nerves like the larger vessels, as displayed by their susceptibility both of inflammation and pain.

DXVII.

From their frequent communications and anastomoses with each other in their course, they in general form an irregular net-work, which is most numerous in the vicinity of the glands, into which they divide.

DXVIII.

Their whole extent is intercepted by valves of a semicircular form, placed in pairs, with one edge fixed and the other loose across the cavity of the vessel, but pointed towards the general termination. The situation of the valves is not always regular, or at certain distances, nor is their number always the same in the same space, though 7 or 8 are the usual number in the length of an inch. Their number varies both in different bodies and in different parts of the same body. The size of the vessels, when distended, is always largest on the side of the vessels towards their termination. Hence their jointed form in the lymphatics, and vesicular appearance in the lacteals; and at the point of their termination there is always one or two sets of valves to prevent any regurgitation into them. Thus the valves promote the course

of their fluids, and prevent the regress of their contents as they pass on. By this set of vessels all fluids applied to their origin are taken up in consequence of capillary attraction, and urged on by the power of the vessels till carried into the general mass.

DXIX.

The glands connected with the absorbents are peculiar in their structure. Their situation in various parts of the body is under the skin, in the cellular membrane, or over the trunks of the different blood vessels belonging to the viscera. Their form is round, or oval; their size never exceeds an inch in diameter, and they are often collected into a mass, varying in colour in different parts, and at different periods of life, being large and reddish, or brown, in youth, but small and pale with increasing age. Under the skin, also, they are redder and firmer than within the large cavities, and are covered by a smooth dense membrane, which gives them a shining appearance, and is connected to the glands by cellular membrane.

DDX.

These glands, like others, are provided with blood vessels and nerves; and they possess sometimes internally a cellular appearance, at other times they consist of a simple convolution of vessels. The absorbents entering the gland, as they ap-

proach it spread into radiated branches, termed *vafa inferentia*, and then penetrate its substance. From its opposite side, vessels go out in the same manner as they entered it, termed *vafa efferentia*; but they are larger and fewer than the former. Many of the absorbents enter several glands before passing into the thoracic duct, and by these glands a change is certainly made on their contents; the particular nature of which is not yet ascertained...

DXXI.

In examining the distribution of the lymphatic, or absorbent vessels, the superficial set of the lower extremities which lie between the skin and muscles belongs, in general, to the teguments. Round the toes they form a plexus, and the same on the foot, from which branches run along the knee. The same takes place on the outer as on the inner side; and the branches here divide, one part crossing the tibia, and joining the same set at the knee; the other part, passing into the popliteal glands, and thence ascending, in part, to the thigh, which glands are near the artery, and buried in fat.

DXXII.

From the knee a plexus from 12 to 14 trunks passes to the groin by the fore and inner part of the thigh, accompanying, in their course, the great saphena, and receiving branches from the adjacent parts in their progress, till they pass into the

inguinal glands, which are from 6 to 12 in number, of different sizes, situated in the angle between the thigh and abdomen, and part further down on the fore part of the thigh. The superficial lymphatics are chiefly centered in the lowest glands; and into this cluster pass also those of the thigh, nates, abdomen, and leins.

DXXIII.

The deep set of the lymphatics of the lower extremity are few in number; they occupy the blood vessels in their progress, and, like the former, pass into the popliteal glands; and, as they proceed up, they accompany the femoral artery, and enter also the inguinal glands.

DXXIV.

Of the scrotum, the superficial lymphatics enter likewise into the inguinal glandular cluster, and the deep seated ones are carried, with those of the testicle, into the abdomen. The superficial lymphatics of the penis run principally on its back, receiving branches from its inferior surface; and at its root they divide into right and left, passing on each side into the lower glands of the groin.

DXXV.

The deep seated set from the glands and body, accompany the arteries into the pelvis.

DXXVI

The testicle is distinguished by the largest and

most numerous lymphatics in the body, some of which exceed in size a small quill. They arise from the coats, body of the testicle, and epididymis, and passing into the spermatic chord, they terminate in the lumbar glands. The lymphatics in the internal parts of women go partly to the inguinal cluster, and partly by the course of the round ligaments, and they terminate in the iliac, or lumbar glands.

DXXVII.

All the superficial lymphatics of the under part of the belly, loins, nates, and round the anus, pass into the inguinal glands; and these glands, thus supplied, send out but a few larger trunks in return, which enter the belly under Poupart's ligament, in company of the iliac artery. Having entered the abdomen, they are variously distributed to the glands above the iliac and lumbar vessels. The iliac glands being equal to those in the groin, and the lumbar larger, and lying over the great vessels and lumbar vertebræ; and in these glands also all the other lymphatics of the inferior extremity terminate, from whatever quarter they come.

DXXVIII.

Besides these lymphatics, now described, on the inside of the iliac artery, others are situated; on the outside of it on the psoas muscle, one part of which passes by to the lumbar plexus into

the thoracic duct ; another part forms a plexus on the sacrum, and from that proceeds to the same termination.

DXXIX.

The lacteals again begin on the inner surface of the intestines, each beginning upon one of the villi by short branches, which are furnished with orifices for imbibing the chyle. From the villi, their progress is along the outer coat of the intestines, which they obliquely penetrate at last, after uniting into larger branches in their course. Their progress accompanies that of the blood vessels, to which they are double in number, one being placed on each side of a vessel ; and both the superficial and deep-seated lacteals communicate in the substance of the intestines ; and, on leaving the intestines, between the folds of the mesentery and mesocolon, they form a plexus, without regard to the course of the vessels. In their progress they pass through a number of lacteal and mesenteric glands of different sizes, the latter being seated in the part between the layers of the mesentery, and scattered over it at the distance of two or three inches from the intestines, of a white colour, and flattened before. The lacteals are largest on the jejunum, and the glands are also largest on that part of the jejunum connected with the mesentery.

DXXX.

By the size of these glands the lacteals have been divided into different orders. From the intestines to the glands forms the first order; one set of glands to another forms the second order; and from the glands to the thoracic duct forms the third order.

DXXXI.

The small intestinal lacteals, on leaving the mesenteric glands, in three or more large trunks accompany the mesenteric artery, and pass in, for the most part, at the beginning of the thoracic duct. The large intestinal lacteals are centered in the mesocolic glands, and those of the cæcum and right colon communicate with the small internal lacteals; while those of the left colon accompany the mesenteric artery, and are lost in the lumbar glands.

DXXXII.

The stomach possesses two sets of lymphatics proper to each of its curvatures. The lacteals of the small curvature accompany the superior coronary artery, pass into the glands of the omentum minus, and observing the same course with those of the liver, terminate in the thoracic duct. The lacteals of the great curvature go to right and left. The right side lacteals joining those of the great omentum, and the plexus accompanying the coronary artery, run with the lymphatics of the liver

to the duct. The left side lacteals join those of the spleen and pancreas, and accompany them into the duct.

DXXXIII.

The lacteals of the liver run also in two sets, which freely communicate, and they are so numerous as to cover almost the whole of its outer surface. They discharge their contents partly into the beginning of the thoracic duct, and partly to a plexus situated on the fore part of the thorax.

DXXXIV.

The spleen also possesses two sets of lacteals. The superficial set is remarkably small. They pass from its convex to its concave surface, and join the deep seated ones at the fissure where the blood vessels enter, and they afterwards pass through several glands, lying over the splenic artery. The lymphatics, also, of the spleen, receive those of the pancreas, which run into them, and the whole goes into the thoracic duct, near the termination of the lacteals.

DXXXV.

The superficial lymphatics of the kidney are only visible in it when it is under disease. They run from without inwards, and terminate in the lumbar glands, and so at last in the duct. Those of the renal glands join the lacteals of the kidney.

DXXXVI.

The lymphatics of the lungs are numerous. The superficial set forms large areolæ, with smaller ones within them. The large set runs chiefly between the lobules, while the small passes so as to cover the whole substance of the lungs. From the surface they pass to the root of the lungs, and enter the bronchial glands already described, (CCCXVI.), where they are joined by the deeper set that creep along the branches of the trachea and pulmonary blood vessels, and through the medium of the bronchial glands the two sets communicate. On leaving the bronchial glands, those of the left lungs terminate partly in the thoracic duct behind the trachea, and another part passes through glands behind the aortal arch, and run by one trunk into the duct. Part of those of the right side, after a convoluted course on the vena cava, opens into the trunk which terminates in the veins at the right side of the neck, and the rest go into the duct near the division of the trachea.

DXXXVII.

The absorbents of the heart are numerous, but small. Their principal trunks accompany the coronary arteries, the largest belonging to the left ventricle, and they all pass to the neighbouring glands.

DXXXVIII.

The lymphatics of the œsophagus are numerous, and intermix with those of the heart and lungs.

DXXXIX.

The superior extremities, like the inferior, have two sets of lymphatics, one lying under the skin, the other accompanying the principal blood vessels.

DXI.

The superficial set is numerous, and arise from the fore and back part of the finger and hand, forming an extensive plexus on the corresponding sides of the sacrum. Those of the anterior part observe a direct course upwards, while those of the posterior separate and pass obliquely. From the bend of the elbow the first accompany or run near the basilic vein, and enter small glands in the course of the humeral artery; others do not communicate any where till they enter the axillary glands. Some branches attend also the cephalic vein, and afterwards pass into the glands at the clavicle. The deep set accompany each principal artery, and uniting at the elbow, pass on in two large trunks along with the humeral artery.

DXLI.

The axillary glands form a cluster, varying in number and size, though less than those of the groin. They are surrounded by much fat, and adhere closely to the trunks of the axillary blood vessels and nerves. From them large branches enter the clavicle, and form a trunk which joins the duct near its termination on the left side.

The axillary glands receive the subcutaneous lymphatics from the back part of the thorax, of the teguments and muscles of the scapula, and also from the mamma.

DXLII.

The lymphatics of the mamma are numerous; though the greater part passes through the axillary glands, others penetrate the interstices of the ribs near the sternum, and enter glands that pass with the internal mammary vessels.

DXLIII.

The lymphatics on the outside of the head accompany the blood vessels, and enter glands as they proceed to the neck; and then others, partly connected with the parotid gland, and some at the root of the zygoma. The lymphatics of the back part of the head enter glands at the root of the ear. Those of the fore part accompanying the facial artery, and its branches, pass into different glands situated at the buccinator muscle, at the under part of the lower jaw, masseter muscle, and the inferior maxillary gland.

DXLIV.

The lymphatics from the inner nose pass with the maxillary artery, and enter glands behind the angle of the lower jaw, where they join those of the mouth. The lymphatics of the tongue and front centre in the glands behind the angle of the lower jaw.

DXLV.

The existence of lymphatics in the brain is highly probable, though not yet decisively ascertained.

DXLVI.

All the lymphatics of the head accompany the large vessels in the neck, forming in their course a remarkable plexus of numerous glands, situated near the blood vessels, termed *glandula concatenatæ*, which are more numerous than any set in the body, and unite at the bottom of the neck into a trunk, which enters the duct on the left side, near its termination, and on the right goes into the trunk that forms the general termination of that side.

DXLVII.

Having thus traced the course of the lymphatics, something farther is necessary with respect to their general termination in the duct. At its under extremity the duct is composed of three principal trunks. The first and second consists of the lymphatics of the right and left inferior extremity, and the third is joined by the lacteals or intestinal vessels. From these is composed the duct over the 3^d vertebra of the loins. In the thorax, the duct in addition receives the lacteal trunks of the intercostals of the œsophagus and of the lungs; and passing over after leaving the thorax to run between the longissimus colli and internal jugular

vein, it next makes a turn down to terminate in the angle formed by the left internal jugular and subclavian vein. In its whole course it observes a waving direction; and after leaving the thorax, sometimes divides into two.

DXLVIII.

Chemical Analysis of the Contents of the Lymphatic System.

The contents of the lacteals were already examined under the name of chyle.

The lymphatic vessels, again, contain a colourless fluid, or a gelatino-albuminous water, having no taste, and of a thin and somewhat plastic consistence, being a solution of the superfluous gelatin and albumen from every part, and the superfluous aqueous vapor returned as it were to pass anew through the general circulation, and to assimilate as it enters the thoracic duct, the chyle or nourishment on its primary entrance into the system.

DXLIX.

Anatomical Preparation of the Lacteals.

The subjects most proper for lymphatic preparations are those who have died anasarcaous; and in order to discover these vessels, make an incision in the cutis, and remove it as far as the cellular membrane. In this part a magnifying glass will observe them, and then with the point of a lancet cut an orifice in one of them, into which introduce the pipe, which is to be kept in that situation by the finger, or a ligature; and when the cock is turned, the quicksilver will be seen to run up the lymphatics. As long as the column of mercury continues to lessen gradually, we are to hold the pipe in its situation; and when it ceases to run any

longer, the injection is to be secured by a ligature, and the pipe withdrawn. The exit of the mercury from any collateral branch, is farther to be prevented by a needle and ligature. The injection being thus finished, the course of the vessel is to be cautiously traced with the scissors and forceps, avoiding any injury to the vessel; and should it take place, it is to be repaired by securing the injured part by the finger and thumb, and passing a fine ligature above and below the part.

During the progress of making lymphatic preparations, which are slow and tedious, the parts should be prevented from drying by avoiding their exposure to the air, or covering them with a wet cloth. When the preparation is finished, and cleared of all fat and extraneous matter, it should be dried in the air without heat, and when dry, varnished.

All the lymphatic preparations are made in the same manner.

DL.

Having now treated at length the structure of the animal body in a sound state, and its different parts, it will be proper to take a general view of the three great systems which support it, the vascular, absorbent, and nervous, in a connected manner.

DLI.

General View of the Vascular System.

Beginning then with the vascular system, we observe the coats of the arteries are of a considerable thickness; and as these require nourish-

ment and growth like the rest of the body, numerous small arteries are distributed on their coats, what writers call *vasa vasorum*. The coats of the pulmonary artery are supplied from the aorta.

DLII.

Structure of the Arterial Coats.

When the coats are dissected, upon the outside, besides common cellular substance, or in some places the addition of membranes laid over the artery, as in the pleura within the cavity of the thorax, there is a loose cellular substance every where; and on separating it, we observe that the outer part of an artery is of a whitish colour. This whiteness depends on a tough and elastic coat, in which a number of exceeding minute fibres are interwoven in all directions, so that this outer coat may very properly be considered as cellular substance condensed; for the fibres do not appear to run more in one direction than they do in another, so we shall call it *cellulo-membranous*, or the *membranous external coat*, which is of considerable thickness. This raised, we find within it one without fibres laid transversely, or in a circular manner. These are of a pale red colour, or paler than the principal muscles of the extremities; so, examining the femoral artery, we find fibres of a paler colour than the *m. adductor* of the extremities, but very distinct; but it certainly carrying matters too far a great de-

when the coats of an artery in general, or all the coats, are considered as being cellular substance condensed.

DLIII.

To judge from appearances, the name of muscular is properly applied to this coat; and there is no more reason, from any thing we observe, to suppose it composed of cellular substance, than to suppose any of our muscles to be so. Within the fibrous muscular coat we find an inner coat, or we find this lined with an inner coat which is extremely thin, but very dense; neither is it strong, and it has less toughness than we should have expected, having scarcely any of the elasticity proper to arteries; for, if the outer coats are dissected, it scarcely admits of being stretched; and these three coats are connected to each other by the common cellular substance of the body, as in the alimentary canal, &c. In other animals, as that of the ox, and especially in the whale, the fibrous coat is still more evident and distinct.

DLIV.

Next, in the coats and structure of the veins, those of the small ones are so thin and transparent, that we cannot distinguish the one from the other; but in the larger veins we find nearly the same number. The second is somewhat reddish coloured in the larger veins. In it we can distinguish fibres, but very different from the fibres of

an artery; for they are not placed chiefly in a circular manner, but so many run length ways; these are crossed by others, and the threads of both are interlaced; so that we are at a loss, judging of it merely by inspection, to determine the nature of that coat. Next the blood is a membranous thick coat, which is tougher than that within the arteries; and the elasticity of the veins very much depends upon the inner coat, whereas in the arteries it depends chiefly upon the outer coat. The cellular substance, too, is rather looser, so that we can separate the external coats easier from the internal than in the arteries.

Such is the general structure; and from it we proceed to trace the course of the blood.

DLV.

In respect to the shape of an artery, many authors have described it as if it was conical; but if we attend to it, in any place where minute branches are not sent off, we find it cylindrical; or we may compare an artery to a tree, which we are likewise apt to imagine of the conical shape, not attending to the change made by the wood furnished to the branches from the trunk, for between the branches it is likewise cylindrical.

DIVI.

In regard to the mode of ramification, or the proportion in which an artery branches, compared with the trunk; as on the right side of the

neck, for instance, and at the bottom of the abdomen, it is evident that the two branches joined together are larger than the trunk, and the proportion nearly, as commonly alleged, is as three to two; the two joined together are a third larger than the trunk which forms them. Hence, as we find such divisions, and subdivisions of arteries, frequently repeated, as in the mesentery, the sum of all the ultimate branches of an artery, or their capacity, must be considerably greater than that of the trunk; and therefore, instead of conceiving that the arteries are conicals with the basis turned towards the heart, we may just invert this, and compare the arterial system to a cone with its point beginning in the heart, and the size continually increasing to the most distant extremities.

DLVII.

With regard to the kind of angles which the branches of the arteries form, in general we may observe that the blood enters them in a favourable direction, or that the angles are acute; but in this there is the utmost variety, which partly depends upon necessity and situation, partly upon the use which the arteries serve; for in many places we find them sent off nearly at right angles, and in some few the angle is turned back in the most unfavourable way, the blood moving retrograde, as it were. Upon the whole, we may observe, that near to the heart the angles of the

arteries are greater than at a distance. Nature seems to endeavour to render the flow in all as equable as possible. So we find many arteries of the trunk that are destined for muscular organs, sent off nearly at right angles; whereas, in the extremities, they are almost every where acute. Perhaps, further, we may remark, that near to the heart the arteries arising from the trunk are spread out in a greater number of branches. Following an artery to the place where it is intended to be distributed, we frequently find, almost without exception, that the neighbouring branches communicate, or we discover a beautiful net-work of the branches, as in the alimentary canal; so that, although a number of branches were stopped, the blood could penetrate to the extremities of every branch; and if, in the course of the artery from the heart to the distribution, there is any danger of a considerable stoppage, we find considerable anastomoses in the large branches, as in the mesentery.

DLVIII.

It is impossible to trace, by dissection, the arteries to their ultimate termination with our senses unassisted. A microscope is required to view the circulation in a living animal; for, if we attend to the circulations that have been made by the most eminent physiologists, it is proved to our satisfaction, that three or four thousand of such

arteries as circulate red blood laid together, do not exceed the breadth of an inch; or, that the smallest hair exceeds the diameter of the artery at least in the proportion of twenty to one; or, that four hundred such arteries circulating the red globules joined together, would not be larger than a single hair. Hence, after we have forced an injection from the arteries into the veins, or into the most minute branches of the arteries, we perceive little more than an uniform red colour with the naked eye, as in the innermost coats of the alimentary canal.

DLIX.

The veins returning from the extremities of the body, in their first origin imitate the arteries in their appearance, and there must be the same number of them. There are two small anastomoses, which are occasionally repeated in the progress of the veins towards the heart; and these anastomoses are, in general, more frequent in the veins; for, as the force of the blood is less here than in the arteries, there is a greater danger of its stoppage. And, for the like reason, where the veins are subjected to unequal pressure, as where they run among muscular organs, in the trunk of the body, the head, and extremities. Within the veins there are numerous valves, or flood gates; and wherever the veins appear joined, there a pair of valves are to be found. Nor is

this alone sufficient; but in the muscular parts two sets of veins are conspicuous, one following nearly the course of the arteries, and the other running under the skin; where they are as little exposed to the action of the muscles as possible. And not only do these anastomoses take place, but we find branches passing from the one to the other, so that on opening a vein the flow of the blood is increased by causing the patient to play with his fingers, which puts the muscles in action, and presses upon the deeper veins. When the veins are traced from all the parts of the body to the heart, we find that the two *venæ cavæ*, joined together, are considerably more capacious than the aorta, nearly in the proportion of two to one, for the inferior is nearly as much larger than the aorta, as the superior is smaller than it. With this general structure we are led to consider the action of the parts by which the circulation of the blood is performed.

DLX.

That the blood is carried constantly in a circle, appears from the vascular structure which directs it in its course. We find valves at the mouth of the ventricle of the heart, at the mouth of the arteries, and in many places of the veins; and, again, where the inferior cava terminates in its corresponding auricle. If we examine living animals, this is made still clearer. We find proof

of the motion from ligatures made upon the vessels, or from wounds inflicted, or from the transfusing the blood out of the body of one animal into another's body ; or we see proof from the infusion of medicated substances, which, when poured into a single vein, or artery, affect the body universally, and the blood may be shewn moving with the microscope.

DLXI.

The rapidity of the motion is likewise easily demonstrated. Thus we see, that a vast quantity is lost from a wound made even in the corresponding artery, the discharge would be greater, because the veins are more capacious than the arteries, and therefore the flow of blood is slower ; or we see the proof from the transfusion of the blood ; or without any regard to experiments, we have only to attend to the quickness of the pulse, to the frequency of its strokes, and to the capacity of the heart. From them we perceive that a prodigious quantity is passing through the heart in a very short space of time, our pulse beats between 60 and 70 times in a minute ; when a person is laid at rest in bed, suppose it 64. Thus, if a single ounce of blood be thrown out from the left ventricle of the heart in each pulsation, it is evident that there passes through the heart in a single minute 4 pounds of blood ; but if we double the quantity, which from the size of the ventricle we

may easily do, eight pounds may pass in a minute ; therefore, in the space of an hour, blood, equal in weight to thirty stones, or perhaps to three times the weight of the animal to which it belongs, passes in that space.

DLXII.

This velocity of the blood depends upon the action chiefly of the auricles and ventricles of the heart ; and these act alternately. Whilst the auricle is filling from the veins, the ventricle is emptying itself ; and whilst the auricle empties itself, the ventricle is filling ; and the use of each is clear, in order to give room by their being a receptacle added to the heart. There is no alternate considerable dilatation of the veins ; for, whilst the ventricle is in action, the blood continues to flow, as before, from the veins into the auricle ; and as soon as the ventricle ceases from its action, the auricle, now stimulated by the blood, contracts, and the blood flows into the ventricle with great quickness, whilst, at the same time, an addition is made from the veins. Hence the auricles are smaller than the ventricles, and there is nothing placed to prevent the flow of blood continuing into the auricle directly from the veins during the contraction of the ventricle.

DLXIII.

What is known of one side of the heart applies to both. We conceive that the two auricles are

filled and emptied at the same time, but at a time different from the ventricles ; having, as appears from this, a common septum, and we cannot suppose that the half is relaxed, and the other in action. Indeed, the synchronous actions of these parts may be seen in a living animal. But though the auricles and ventricles are emptied at the same time, they are not entirely emptied, but nearly so ; for the right side is somewhat more capacious than the left, so this certainly does not empty itself fully, but they do very nearly ; and, we may say, that the auricle is filled and emptied alternately. But our blood vessels are in a very different state. The sides of the arteries do not come into contact when in action, only they are more stretched at one time than at another, and are more stretched when the ventricle is in action ; but they are by no means emptied when they contract, and this leads us to attend to the cause of the pulse.

DLXIV.

When the finger is applied to the artery, it is understood, in general, that the artery strikes the finger, because the blood is driven from the heart into it with violence. But, farther, what changes does this produce ? Are we to say, that the artery is merely dilated, its diameter increased ? Or, are we to say, that it is not dilated, but lengthened, in consequence of which it

changes its place? Or, are we to adopt both? We certainly must; for to imagine that an artery is not dilated, is improbable. We find that it can be drawn out in its diameter, as readily as in the length, and it re-acts with considerable force; and the muscular fibres, on which the elasticity in a great measure depends, are placed in a circular manner. It is in vain to allege, that when we make a computation, the quantity of blood that the heart supplies appears to be inconsiderable, considering, at the same time, the great capacity of the arteries; and, therefore, that the change in dilating them cannot be observed. For, in this computation, it is taken for granted, that the whole is diffused universally in the arterious system; but the arteries beat successively: and, if one hand is laid on the carotid artery on the neck, and another upon that on the top of the foot, it will be perceived that the one succeeds the other, and the dilatation, as well as the elongation and change of place in the artery may be plainly seen; but both seems less to the eye than to the finger, for we are affected by the force of the percussion, and imagine the motion greater than in reality it will be found to be. Hence, when we throw an injection into it, the artery, instead of becoming shorter and straighter, is lengthened out, becomes more serpentine, and at the same time is dilated.

DLXV.

By what powers, after the arteries have given a stroke to the finger, do they recover their former situation? Is it merely by their elasticity, or that whilst they are elastic, they are likewise muscular? Their elasticity is known, and the use of it is apparent; it is intended to prevent the whole force of the heart from being spent: the force is eluded by the yielding of the larger branches, and the impulse is continued, instead of being given in one moment. Nothing is lost, and nothing is added by the elasticity. The force is as much lost by the yielding, as it is increased by the re-action; the force is the same, but divided; part of it is employed when the heart is in action, and then it is continued when the heart ceases.

DLXVI.

With this elasticity a muscular power is joined, for the fibrous coat is truly muscular; and we may, therefore, with certainty conclude, that the arteries are muscular organs capable of irritation, of varying their action occasionally in health, and in disease; and the proof of this is full and complete. The contractions of arteries are apparent when irritated, and a greater motion is performed at the place irritated than elsewhere. In many instances this cannot be shown so clearly as might be expected; but the same is true in other organs. Thus it has been found, that the vesica urinaria

may, on certain occasions, be wounded and cut on the outer surface without suffering a contraction of its fibres; and many difficulties are to be had in view here. If a ligature is thrown upon an artery in order to intercept the blood, that it may be seen what passes beyond the ligature; or an incision is made, then may have been compressed or divided those very nerves on which the motion of the cut muscle depends. The irritation, too, is applied not in the natural way. It has been made upon the outer side, whereas, if applied to the inner side, the effect may be very different. Thus, whilst the arteries possess the muscular power, they possess at the same time the elastic; and it is by no means improbable that in several places the elasticity straightens the artery as much as the muscular power can do, so that it is not made smaller in life, but a greater impulse only is given to the blood. If these things are properly considered, and the experiment made with accuracy, we will be able to discover the motion of the muscular coat of the arteries, to which may be added the observations made by dissections, or otherwise. The resemblance between arteries and the intestinal canal is to be also taken into account. We see fibres in both, paler than these moving the extremities; and any person judging merely from the appearance, would call it the muscular coat. We find in certain places nerves

sent into it. This is proved by the appearances under disease, for the existence of spasm must be allowed in different diseases. Do not we see such effects in hysteric persons, or in the ague? or the effect the passions of the mind have, or the effect of mechanical irritation upon the glands; not only the quantity of the secreted liquors is increased, but their nature is altered by irritation. Lastly, it is proved by the effect of topical stimuli.

DLXVII.

For the increased action of the vessels being excited by topical stimuli, gives a proof of the living power of the arteries*. And thus, besides the contractile power, the living power is much more active in the extremities than in the beginning of the arteries; and, could they be equally subjected to experiment, we should find much greater changes produced.

DLXVIII.

The further proof of the muscular power of the arteries, appears from the dissection of them; the regular course of their fibres placed circularly; and from their being provided with nerves, as appears from their sympathy with the other parts of the body. There are many other circumstances which meet together in the same point. We find, that after the death of animals the arteries are empty of their blood, and the veins distended with it; and there is no doubt that this would be found to

be the case, although the heart were suddenly cut out of the body, the arteries would be found capable of expelling their blood forwards to the veins. Besides, several circumstances may be mentioned, as their being actuated in a different manner in different parts of the body, for the arteries have been found to beat more frequently in one part of the body than in another. But independent of this, our proof is full and complete. Not only the passions of the mind, but topical irritation, alters both the quantity and kind of secreted liquors. Irritation produces inflammation, as it is applied to the right eye; and this is not to be explained by supposing that the heart is irritated, and drives the blood forwards; for, were that the case, the other eye should be equally affected; but the vessels of the part are thrown into unusual action.

DLXIX.

From the enlargement of the arteries, the resistance made by their different angles, from their size, the extreme smallness of their terminations, and the infinite number of branches into which they terminate, &c. the stroke of the heart is insensibly lost. Not but the vis a tergo continues, and pushes on the blood into the veins; and its force reaches farther than is commonly supposed. When we observe the circulation in a vigorous animal we observe that the blood is pushed on in

a uniform stream; but when the animal grows languid, and the blood begins to stagnate, so that it requires a considerable effort, the strokes of the heart may be numbered by looking at the vein, and thus the blood is seen moving on a certain way.

DLXX.

Besides the *vis a tergo*, the veins likewise possess a living power, independent of their elasticity; and it would appear that the smallest veins, like the smaller arteries, possess it in the greatest degree. Nay, in the largest veins, we perceive a greater alteration made by heat and cold in a living than in a dead body, owing to that activity of their coats, similar to what the arteries possess, especially that we find many of our veins, particularly the lacteals, in which we can still less demonstrate muscular fibres, are capable of emptying themselves very completely, independent of a mechanical external pressure made upon them. The larger veins are capable of being irritated in life, of having their coats inflamed and thickened.

DLXXI.

Thus the blood moves in the veins towards the heart by the *vis a tergo*, the muscular power of the veins, and the pressure made upon them by the action and swelling of our muscles, while other circumstances may have a less considerable effect. The motion appears nearly uniform in the veins,

till we come near to the heart; for the motion of the blood from the heart is broken; and, unless in an extraordinary situation of the body there is no stoppage, because the auricle receives the blood from the veins during the contraction of the ventricle, and there are no valves interposed which can stop its course, for a very moderate impulse is sufficient to distend the ventricles, which we are not to look upon as a spring, but as yielding to a gentle impulse, so that valves were unnecessary. And, where the respiration is much impeded, if there had been valves pressing mechanically upon the auricles, it might have sent the blood backwards into the vena cava, and in this case we do find it pressed backwards, and a pulsation in the branches, which immediately terminate in the cava.

DLXXII.

When we compare the force of the blood in the arteries with its force in the veins, by fixing a tube in them, we find that the blood rises ten times the height in the arteries that it does in the veins; *i. e.* it loses nine tenths of its force in passing through the arterial system. Hence one, and a primary purpose of the heart, is to renew the force of the blood; and upon this activity of the heart the circulation in a great measure depends. It is in vain to imagine that the blood runs from the venous system into the heart with

a force sufficient to continue its motion. We see that the heart and brain, by acting upon each other in a circle, have an advantage over every piece of machinery in continuing the motion of the blood with almost unimpaired vigour.

DLXXIII.

But there are many other uses which the circulation of the blood serves.

1. The thoracic duct terminates in a large vein near to the heart, and the heart and arteries are perfectly well fitted to mix the chyle with the mass of blood.

2. The general motion of the chyle through the heart and arteries forms it into blood, all parts contributing their share, some more than others, and especially the lungs, occasion the conversion to be complete, by the appearance of red globules which is acquired from the degree of oxydation that gives them colour, and this appears wherever we compare breathing animals with others, or consider the effect which air has upon the mass.

3. The blood thus formed, is preserved in a proper state of fluidity, and the coagulation in a great measure prevented. The excess of air, indeed, disposes to the coagulation of the blood, as appears in morbid cases. Thus a quantity of fluid contained in the cavities of the pleura, when the body is opened, though perfectly fluid, in a few

seconds after exposure to the air will coagulate, which shews the effect of the air in producing that circumstance; but this does by no means show that certain parts of the general mass cannot be coagulated without that. On the contrary, all anatomists have found it coagulated in the ventricles of the heart, and we see it quickly taking place in aneurism; and after tying a large vein in two places, the blood has been found coagulated in it. In short, upon a variety of occasions, we see the spontaneous separation of the blood into its constituent parts, and find a coagulum of considerable firmness in no great length of time.

4. The circulation conveys the nutritious parts every where, and applies the nourishment repeatedly; for the parts of the chyle, or of the blood, are hereby repeatedly applied to their proper organs, in order to be separated from the general mass. Thus the separation of the milk depends upon this circumstance; the same quantity could not be collected without the constant motion of the blood in a circulation, and in like manner with regard to the other secretions.

DLXXIV.

There are other purposes which we shall afterwards more clearly discover, while we consider the effect of the glands in certain parts of the circulating system, by which not only a separation is made, but the liquors are changed at the same time,

and a difference made between the secreted liquors and the red blood, in the same manner as between red blood and the chyle.

DLXXV.

We find many other circumstances depending upon the same cause. The growth of new parts is supplied, and that in a manner that is extremely curious, and which is almost inexplicable: for, after making an incision in a part, a circulation can be restored between the opposite sides of the incision; or, if a loss of substance happens in a part, a great number of new vessels are formed. Were we only to consider a formation of arteries, it might not appear so strange; but how do these join with veins to return liquors to the heart? the thing certainly happens, that the new arteries meet with new veins that return the blood.

Other phenomena may be supposed to depend upon the circulation, but they cannot be shown to do so with equal certainty.

DLXXVI.

Absorbent System.

From viewing the arteries as serving merely for the purpose of circulation, we now proceed to consider their termination, and the beginning of the veins more particularly; and in doing this we shall also review those veins which are universally known as the system of the valvular lymphatics. They are generally pellucid, and every where

crowded, as is found, with valves; so that in an inch eight pair of these valves may be reckoned, and their structure is exactly the same in the human body as that of the valves found in the red veins. There are almost always two valves together, each describing its semicircle, and filling the vein exactly. As it is of very considerable consequence, not only in physiology, but in practice, to understand their course as well as structure, they deserve a particular demonstration.

DLXXVII.

We find that they enter into small knots, or glands, which have been described, from their shape, under the name of conglobate glands. When they reach, they divide into a very great number of branches, which are so minute that it is difficult to force a penetrating injection through them. When we succeed, we find, that after dividing within the gland, the extremities of the vessels open into cells which are natural to these glands, and in which the chyle and lymph are deposited; for, in describing them in general, it is all one whether we take the lymphatics come out from the small glands beginning equally small, and a number of these minute branches joining together form the trunk. So we may call the first of these *vasa lymphatica ingredientia*, and the others, the *vasa lymphatica egredientia*, supposing, always, that a cellular matter is interposed; just as when blood is thrown by the arte-

ries of the cellular substance of the penis, it passes into cells, and from thence into the veins. These vessels, in their course, have numerous anastomoses. Thus, two lacteals run a certain way parallel, each sends off a branch, which are united to form a third, and each of these three is again subdivided, and thus we may pursue the anastomoses a very great way; and hence no lacteal can be readily obstructed, for, if the passage is denied to the right hand, the liquor can run to the left. When the lymphatic reaches a conglomerate gland, the whole of it does not enter into the gland, but it divides upon the surface into different branches, some passing over the gland, and others entering it; and they communicate again on the other side of the gland; and, therefore, though the gland should be obstructed by disease with an osseous, or rather cretaceous matter, &c. still the lymph can pass on. When we follow the lymphatic and lacteal system, we find one principal or general termination in the thoracic duct.

DLXXVIII.

In tracing them from the extremities, we perceive two sets, one accompanying the subcutaneous veins, the other the arteria and deep seated veins; and as they run upwards, the deep plexus comes nearer to the superficial. When we trace them near to the groin, we find the superficial plexus

passing into the inguinal glands, and from these the egrédientia entering the trunk behind the tendon of the external oblique muscle, while some of the deeper branches are seen entering at the side of the pelvis, and repeatedly the superficial vessels communicate with those following the artery, then within the body they enter other glands. Therefore, we take it for granted, that the shewing a conglobate gland is the same as shewing lymphatic vessels; and running up alongst the loins, they pass through the glands of the lumbar plexus, and here they meet with the lacteal vessels, the lacteal trunk joining with the lymphatic, and running to the receptaculum chyli. The thoracic duct, in its course, receives the lymphatics of the trunk; and, where it makes a turn to open into the internal jugular, there enters a large lymphatic, which receives the lymph from the left side of the head and neck.

DLXXIX.

Thus we have seen that the thoracic duct receives the lymph from the lower extremities, from the pelvis and abdomen, with the chyle from the chylopoetic viscera, then, in its passage upwards through the thorax, it receives the lymph from the heart and lungs. We find the plexus from the left arm going through the axilla, and running towards the thoracic duct with the lymphatics of the left side of the head and neck; while those of

the right arm, and of the right side of the head and neck, enter the internal jugular vein of the same side, and right subclavian.

DLXXX.

The general termination of the arteries has been hitherto mentioned in circulating veins, without any regard to the colour or nature of these veins; but when we attend to the composition of the blood, that there are found in it red globules of a considerable size, and that the parts composing the serum and lymph are invisible to the microscope, we may suppose that some of the terminations of the arteries, those that convey the red globules, are considerably larger than others which convey the serum or lymph only; that, as we find the blood, when set to cool, divides into two parts, a red part and a colourless, we might naturally suppose, farther, that in the course of circulation these parts were separated somewhat in the same manner. When we compare with this notion the appearance of colour in different parts of the body, such a separation must actually take place. We find no red blood within the cartilages, nor any red vessels upon the clear part of the eye, and hence we certainly will admit that there are arteries of a descending series; thus there are red arteries, and others to which we may apply the name of serous or lymphatic. When we use the term lymphatic, we do not mean that the

coagulable lymph, unmixed, passes through these, but that this is conveyed by a certain portion of the serum; but we can even suppose the serosity separated from the lymphatic part, and again pure water taken in by drink, separated from both; and it is beyond all doubt, that there are serous as well as red arteries.

DLXXXI.

Besides those performing circulation, we all know that many parts are separated from the blood; that there are secreting vessels, that make a separation either of what is hurtful to the body, were it to remain longer in the course of circulation, or what may be useful in various respects, as milk to nourish the child, or bile and other liquors that are afterwards to be employed for useful purposes, for the preparation of our aliment.

DLXXXII.

The secretion may be made in a very simple, or in a very complex way, and that varying in different parts of the body. For, whilst we use the term of secreting arteries, we would be understood to mean that, whilst the arteries make a separation, they at the same time alter the liquors that pass through them.

DLXXXIII.

Authors generally imagine that the liquors which are little changed, perhaps scarcely at all changed,

merely water are secreted from what is called an exhalant artery; but of late years, some authors of eminence have taken the fancy of denying that there are exhalant arteries, and would persuade us that, were we not to observe a glandular mass, the secretion is performed through inorganic pores. But this is improbable and inconsistent with anatomical facts on the different parts of our body, as on the inner side of our lungs, and of the alimentary canal, we find glands for the separation of slime or mucus; but, besides this, there is a secretion of matter which possesses very singular powers and properties, which is deposited into the trachea, and impregnated with a remarkably poisonous quality. The matter secreted into the cavity of the stomach and intestines, possesses singular properties in dissolving our aliment: can we imagine that such variety is made by an exudation through inorganic powers? Are not we rather to suppose that the structure is organic, and highly curious, through which such liquors can be produced. If we push an injection a little, we perceive regular terminations of these vessels into cavities which can be plainly demonstrated. And we observe that even the quality of these secreted liquors can be varied and modified by irritation. Thus, upon the surface for instance, the secretion is affected in various diseases by spasms. Therefore, though the notion of exhalant arteries has

rather been taken for granted, than proved by systematic writers, the more we consider the matter we shall the more readily adopt the idea. Generally there is a knot or gland interposed, into which we trace the termination of arteries, as in the separation of the bile, &c.

DLXXXIV.

From the facts thus stated, there can be no doubt that the red arteries divide into coloured and colourless branches, that many of the colourless branches serve for the purpose of secretion or excretion, or that we find exhalant arteries sent off. In other cases, a number of arteries collected, by their complication form a knot or gland, from which we find a duct sent out, while others of the colourless branches, with the red extremities of the arteries, perform the circulation. Thus we cannot doubt that the cornea of the eye has a circulation through it nearly in the same manner, as that performed in the other coats.

DLXXXV.

But it remains that we determine the course these fluids afterwards take to return to the heart. There must be circulating veins corresponding to the red and lymphatic arteries, and there must be absorbent veins that suck fluids in, corresponding to the exhalant and fecerning arteries, and besides, serving a variety of other purposes. Thus the moisture is taken in from the air, and we all

know that medicines can be taken in as mercury, the ointment rubbed on the surface having the same effect as when swallowed, and the chyle is taken up from the alimentary canal.

DLXXXVI.

Thus there are two kinds of veins, the red veins and the valvular lymphatic veins; in what manner are we to suppose them formed?

DLXXXVII.

That the red arteries terminate with the red veins, is beyond all manner of doubt; but how are we to send back the liquor contained in the lymphatic arteries, or sucked in from the different cavities? Are we to suppose with systematic writers that the lymphatic arteries from the valvular lymphatic veins pass through the glands, and that the absorbent veins pass into the red veins? Or are we to conceive that the red arteries form the red veins, and the lymphatic arteries form the lymphatic veins, and that the absorbent vessels which are colourless, terminate in the colourless veins; the valvular lymphatic, supposing the red part of the blood to go by the red veins, and the absorbent liquors by both.

DLXXXVIII.

Or is there not another supposition still much more probable, a system that is much more simple, viz. As an artery in its extremities divides into red and colourless branches, would we not sup-

pose that the red veins, in like manner, are formed of coloured and colourless branches, and that both join together to form the red veins, and that they thus correspond with the arteries in one of their principal offices, of carrying on the circulation, and in that only whilst the valvular lymphatic veins correspond with them in so far as they perform secretion, or that they receive all the liquors that are any where effused, so that the circulation is carried on by the red veins, and absorption by the valvular lymphatic veins ; and that these have open mouths beginning from the surface, and from all the cavities of the body, so that the fluids do not pass directly into them by the force of the heart.

DLXXXIX.

In order to fix a proper opinion, it is necessary to state facts and experiments, as well as arguments from the nature of things, to establish some fixed opinion ; and the first thing in doing this is to shew that authors have, not as they suppose, given an absolute and direct proof that the valvular lymphatic vessels proceed from the arteries. The arguments used for this purpose, though at first sight plausible, and seemingly conclusive, when properly examined, are founded in error.

DXC.

As we observe the blood out of the body to divide into a red and colourless part ; and, as we

find in the body coloured and colourless veins, there can be little doubt that each of the veins corresponds to the parts of the different colours; but surely this observation touches not the origin of the veins. Nothing is thence concluded with regard to that. From there being in the body parts that are colourless, we may conclude that the arteries divide into coloured and colourless branches; or we get a proof that there are more arteries than we perceive with the microscope, the colourless branches escaping us from their smallness and the want of globules; so that we have no manner of judging.

DXCI.

The next argument is more direct. We have been told, by a succession of anatomists, and told truly, that when an injection is thrown with violence into an artery, the injected matter is found to fill the valvular lymphatic veins. But several circumstances have been overlooked by the chief persons who have made those experiments. There was a laceration of the tender branches of the artery, an effusion into the cellular substance, and a laceration of the branches of the lymphatic vessels; and the mercury had entered at the lacerated places, which often happens, and without laceration it never succeeds; but if we fill the veins at the same time with the arteries, we seldom remark any of the

lymphatics filled ; whereas, upon pushing an injection suddenly, the materials not of the most penetrating kind, we shall have the lymphatics injected, and not a drop in the veins ; and in many preparations formed of the testicle, many of the lymphatics are filled, some of them very small. The valves prevent the filling them by their trunks, and none of the blood vessels have the matter injected into them ; and the manner of injecting them is to bruise the same substance, to pour the mercury into a hole, and to work it into the several branches of the lymphatics : so we do not find any proof, from these experiments, that the lymphatics are continued from the blood vessels, which is all the use that we can make of such experiments ; for it is not meant to hint that the mercury passed in at the most minute mouths of the lymphatics.

DXCII.

There is another argument of considerable weight ; that the lymph is sometimes found coloured with the red part of the blood. This observation likewise is just, and what is seen repeatedly in living animals ; nay, constantly, it is the case wherever, by a wound made upon a living animal, the blood is effused, or the finer parts of it, a bloody water, whether in the cellular substance or larger cavities of the body, but more especially if by the wound sensible parts have been.

exposed to the air, so as to become inflamed; and it matters not which of the bowels are exposed to produce this effect of tinging the lymph red. Now, what reason is there for such an appearance? are we to imagine that where the red colour is found, where perhaps red globules are found in the lymphatic vessels, that the whole arterial system has been dilated so as to allow these to pass? Only attend to some of the instances; there was nothing before hand to produce the dilatation, which must have taken some time. In the appearances which follow every inflammation, a bloody matter is effused into the cellular substance, and this circumstance was not attended to by those who draw the conclusions that the red colour showed the continuation of vessels; and they overlooked this circumstance, that the red globules break down into invisible parts; so they are perhaps as capable of being absorbed by the found mouths of the lymphatics as any of the other parts. Nay, more readily perhaps; because where the whole mass is effused, the red colour disappears before the yellow. Instead, therefore, of this observation proving a continuation of the valvular lymphatic vessels with the arteries, it rather seems to show the contrary, that the lymphatics begin by open mouths from these cells, into which, in cases of inflammation and wounds, the red particles are effused.

DXCIII.

No proof, therefore, is afforded of the colourless arteries terminating in the lymphatic veins; but do we find any that the colourless arteries do not terminate in red veins? Every circumstance leads to the supposition that they do. This we we find founded first on the analogy of arteries.

DXCIV.

An artery, at its termination, consists of coloured and colourless branches. Why should we not suppose a vein at its beginning to consist of the same? It must be admitted, that nature forms no more of the colourless part of the blood than is proper for the purposes of life, for maintaining the diffusion and separation of the red globules from each other, and for many other uses. Now, if these parts be necessary where the fluidity is preserved by the greater agitation of the heart and arteries, they are certainly more so where the circulation is more languid; and, therefore, after the necessary secretions are made, the remainder should return to be added again to the red globules. Hence, instead of imagining that this part is carried away from the red veins, we must suppose that after the colourless arteries have made their dispersion through a colourless organ, they run into red veins. Thus in the eye of a child we find arteries conveying red blood, which afterwards become too small to admit the

globules, yet the termination of these arteries must still be in the red veins; and, when we view the different places of animals in which the lymphatic system is found, and where there is a greater proportion of colourless fluid, as in a skate, the flesh is of a white colour, so that the arteries must exclude the red globules. If the colourless veins terminated in the lymphatic system, we would find the lymphatics of a prodigious number and size, and the vena cava receiving only the red globules very small in proportion to the aorta, but the proportions are the same as in man. We may therefore apply what we observe in these fishes to ourselves, and take it for granted, that the red veins correspond to the red arteries so far as concerns the circulation of the blood; and if it is proved that the red veins receive all the circulation of the arteries, we leave absorption only as the office of the lymphatic system, and we have direct proofs to show that the valvular lymphatic vessels begin by open mouths at the several cavities, and suck in at their extremities the liquors they convey. The analogy of the lacteal vessels show this; we find the same structure of their coats, which are thin, tough, and transparent; we find them both crowded with valves; we find them both passing through glands, which agree perfectly, whether we consider the shape, colour, and consistence, or the injected vessels. Thus the mesenteric glands, and

the conglobate glands of the groin and axilla, perfectly agree in every circumstance. We find the vessels in a similar way passing along the surface and passing through them; and to carry on the analogy they unite together, so that the thoracic duct is the common cava of both systems. What we observe then of their structure and course, would lead to suppose that they agreed as to the manner of their origin, that the lymphatic vessels begin in the other parts of the body by open mouths, whether on the surface, or from the different parts of the cellular substance, or from the several cavities of the thorax, abdomen, joints, head, and universally. Or let us make the comparison with the red veins. If the lymphatics and red veins had a similar origin, we should probably find the valves disposed nearly in the same manner. We find valves in the red veins only where there are muscles, because their single purpose is to direct the blood to the heart, and these valves are conceived as dividing the vessels into a number of parts, and lessening the pressure of the blood upon the descending veins; but they have not this effect, for if the blood is just now stagnating in the veins, and a motion is made, the consequence is, that the valves are all opened, and the pressure is the same upon the bottom as if the valves had been entire. The pressure is not lessened because the liquor is in motion, but increased; and it matters

not whether the veins ascend or descend to the heart; the only circumstance that requires valves is their passing along muscles; so we find them in the superior parts, in the head, &c. but scarcely within the cavities. But, in the lymphatic vessels, the valves are found every where, and we observe the effect of this is, that the slightest pressure upon them drives the fluids outwards beyond the next set of valves towards the heart. Thus, if we inject a lymphatic vessel with mercury, we must be cautious how we touch it, for it readily goes onwards, and we cannot again fill the interstices between the valves that the mercury has left; thus they are fitted to take advantage of the slightest pressure or impulse; every stroke of an artery passing over them serves to drive the blood onwards. Hence, universally, the lymphatic system is crowded with valves, showing that it wants the same pressure onwards, or the vis a tergo which is found in the other veins; so that as they are fitted to take the advantage of every pressure, they need it to promote their contents.

DXCV.

After an artery is tied up, and the flow from the heart intercepted, the lymphatic continues to be filled. Why? Because it is independent of the artery; and whilst the life, the warmth, sensibility and contraction of the heart continues, the motion in the lymphatic continues, though the

vis a tergo

heart is cut

open, if you empty any vessel by pressure upon it with the finger, it soon fills again, after the motion has ceased in a remarkable degree in the red veins. The same thing appears from the colour and appearance of their contents. Thus, in jaundice occasioned by a total obstruction of the biliary ducts, the lymphatic vessels take up the bile almost as pure and bitter as it is found in the gall bladder, which is a direct proof that the lymphatic vessels in the liver begin from the cavity of the biliary ducts, viz. perform absorption, and so far as proof is necessary this may be sufficient.

DXCVI.

But there are other circumstances which it is very material and useful in practice to attend to. Where acrid matter, whether of medicine or disease, is applied to our body externally or internally, we find, in many instances, that the matter directly enters the lymphatic vessels, and, before it shews its influence on the body in general, produces swellings of the glands, through which the lymph, loaded with medicine or other matter, naturally passes. Thus it often happens, that blisters produce swellings in the conglobate glands, not in those next which the blister is applied, or those immediately under it; but in those so situated as to receive the lymphatic vessels from the

part blistered, however distant, as in the axilla, or inguinal glands, when the blister was applied to the hands and feet, and that without any pains spreading along the member; and surgeons often find that blisters of the head produce wax kernels of the neck, their situation varying according to that of the blister. The same is observable in diseases, as in the plague, perhaps; but, beyond all doubt, in the measles, small pox, cancer, and lues venerea.

DXCVII.

This is a clear evidence that the valvular lymphatic vessels are absorbents, performing that office; and they do so universally, because every part of the body, in a diseased state, can produce such swellings. And the idea of some, that lymphatics are wanting in the brain and some other parts, because anatomists have not yet injected them, merits a serious refutation. Are we to suppose an exception of one organ from the general analogy of all others? That the whole order, not only of absorption, but of circulation, is inverted? The only reason assigned is the difficulty of seeing them. We can bring them into view in the abdominal viscera, but we cannot do this in the brain when the animal is in life. In the brain they terminate in a different manner from what they do in the other parts. There is somewhat particular in the course of the larger vessels, in that

they do not accompany the arteries ; but we find a number of conglobate glands immediately under the brain, in proportion greater than could be supposed, unless the lymphatics of the brain passed through them ; and wounds and suppurations of the brain have brought on swellings of the neck.

DXCVIII.

But, supposing that the lymphatic system does perform absorption, does it follow that the absorbents do not likewise terminate in the red vessels ; or that absorption is not performed by those also ; or while the valvular lymphatic veins absorb, are we to suppose that the red veins assist in the same office ? It is not consistent with the simplicity of nature to make such a supposition, to suppose one set of veins serving the simple purpose of absorption ; and that the other set of veins shall not only serve that, but likewise the purpose of circulation. It is more probable, that as the two kinds of veins correspond to different kinds of arteries, that they correspond entirely, and that the one office has no connection with the other ; but that the red veins serve for circulation, and the lymphatics for absorption.

DXCIX.

If the structure had been fully understood before the other suppositions had been formed, we might have allowed it to have had more weight ; but the red veins were known long before the

lymphatics, and therefore were for many ages supposed to serve every purpose in the body; and even after the discovery of the circulation, they took it for granted, that the red veins served both for motion and absorption. And it was not easy for physiologists, though they now began to treat matters more minutely, to divest themselves of their prejudices; and instead of producing arguments against the former opinion, more were advanced in favour of it.

DC.

Thus it has been alleged, that the lymphatic vessels are wanting in a variety of animals, which in other respects agree with man; so that absorption must be performed in them by the red veins. But we find that in the oviparous animals there are lymphatic vessels.

DCI.

There has been also alleged the want of lymphatic veins in certain places, because they have not been seen, as in the brain and eye, and it has also been appealed to injections. An injection is made into a vein, and it is found that some cavity is filled, and truly water squirted back in the mesenteric vein will be effused; but it may have entered the artery, and passed by its exhalant branches. And reversing the experiment, let us pour the water into the cavity of the intestines, and see if it enters the vein; and if we use coloured sub-

stances, or those that have a strong smell, and which readily enter the lymphatics, we find that they do not enter the mesenteric veins.

DCII.

Wherever, also, a number of the glands have been obstructed, as in the axilla, the whole arm has become œdematous, and yet the red veins are not affected; and if these are provided with numerous absorbent vessels, why do not these perform their office?

DCIII.

Having then endeavoured to determine the nature of the absorbent vessels, let us next consider the way in which we are to conceive liquor to move in a vessel that wants the vis a tergo that is not continued from an artery. The lacteals suck in their contents, or draw it in, in the manner which the vessels of vegetables probably do, or in the manner in which very small tubes draw water from a cistern, and the liquor only enters at all if it be of a mild nature; and hence we learn that our lacteals possess a living power, that they shut their mouths against acrid matter; so they possess motion and contraction to such a degree as to exclude a very thin substance altogether, providing it is extremely acrid. This helps us to explain the progress of the liquor; for, although the water will ascend in the tube a certain way, yet at length it stops; so the attraction of capillary tubes only

begins a motion, it is not capable of continuing it, rising only to a certain height, and then stagnating. To push it on a living power is necessary; and this beyond all doubt is inherent in the lacteal or lymphatic, from its own coats. And, as a farther proof of its being muscular, after the death of an animal, when the lacteal vessels are full, after cutting off the head or heart they empty themselves completely, and push on all their contents into the thoracic duct, so that it is seldom that we can give a demonstration of the lacteal vessels from the colour of their contents. From that it may be presumed that our veins possess a similar power, and chiefly in their small branches. But besides the power inherent in them, they receive a considerable assistance from the pressure of the neighbouring or external parts; and in the intestines it is beyond doubt, that the muscular coat of the intestines alternately contracting and pushing on the fœces, affects the beginning of the lacteal veins; and when the lacteal itself contracts, the valves hinder the liquor from being pressed outwards, so that every pressure determines the fluid to the heart, as the pulsation of the arteries and the action of the muscles. Thus, when a vein is opened, by acting with the muscles of the arm, we accelerate the flow of the blood, and we would do so though there are no more veins in the member, and the lymphatic vessels appear to be

purposely exposed to the action of the arteries, and even swelling of the common red veins, while from their being crowded with valves, they are fitted for taking advantage of the slightest pressure; and the principal trunk of all runs up the thorax parallel to the aorta, so that every stroke of the heart affects it, and pushes forwards the chyle with considerable violence: so we can readily understand the manner in which the liquor enters the absorbent vessels, and is conveyed to the heart.

DCIV.

The principal offices, then, of the absorbent system, or the general purposes that it serves in our body, are various; and the very first one that occurs to us respects the lacteal vessels, that they serve for taking in our nourishment; and what we say of the lacteal vessels even in this view, seems in some measure to apply to the lymphatics. It also prevents the too great accumulation of liquors in the various cavities of the body, unless there was a corresponding absorption to the exhalation into them, every shut sac would soon become dropfical; and, although this was not the case, although they did not supply more than is necessary to make a free motion, yet the liquor by remaining long would become acrid and hurtful, hence the necessity of a constant change; and all the secreted liquors undergo it; persons grow fat and lean, so the absorbents

can take up from the adipose follicles the fat of the body, and there is a continual change of the fatty parts, and of all others in the same manner.

DCV.

We must also suppose that many changes are operated on the secreted liquors, in order to fit them for their several purposes, for we cannot imagine that they come from the arteries with all their properties. Thus, the bile in the gall bladder is much thicker, and materially different from the bile found in the hepatic duct; so it has undergone a preparation, particularly the absorption of the thinner parts. In like manner the fat is separated from the exhalant vessels, not of the same consistence as it is found in the adipose plexus, a watery fluid must have conveyed it there, which is afterwards re-assumed. So in the mucus that is exposed to the air, we find a sebaceous or mucous matter in the follicles or bags of the trachea, &c. and this mucus has been also changed by absorption. Perhaps we may push this one step farther, that the absorbent vessels do not merely serve for the preparation of the secreted liquor, but that a somewhat that is useful to the economy is at the same time taken away and returned to the mass of blood; viz. that by the secretion such changes are produced upon the liquors, that when these are re-assumed, they have different effects upon the body from the effects

of the principles of the blood. Thus it can be rendered probable that in the jaundice, the yellowness is not owing to the want of separation of the bile, but to its being returned to the blood; and if we the return, we can prevent the disease. In the fœmen, also, we observe that the whole constitution is affected by it; if this was owing to a want of separation, the fœtor observed in the flesh of bulls would be more remarkable in the flesh of oxen.

DCVI.

Perhaps it may be asserted that somewhat useful is taken in from the most excrementitious liquors, as the urine; for in fishes there is a vesica urinaria. If all the parts were useless, it might be discharged from the body by the ureters without any inconvenience to the animal.

• DCVII.

We observe in the last place, that the lymphatic system is connected with the lacteal, or rather that the vessels described under two names make one system, and the lymph is mixed with the chyle. Indeed, without this dilution and separation, the mixture with the mass might have proved hurtful.

DCVIII.

Thus, by this doctrine concerning the lymphatic system, a variety of circumstances are explained. Our views are enlarged by considering the absorbent vessels as valvular, for we see more dis-

tinctly the benefit in health, and in disease arising from friction and exercise; whilst the branches of the red veins were considered to perform the office this is less evident; but from the number of valves we cannot rub the body, but we accelerate in a remarkable degree the flow of the lymph, and that will lead to the use of this in a variety of diseases, as in the dropsy, where we are very apt to err in recommending rest and a horizontal posture, which lessens the swellings of the feet, because the erect posture increases exhalation, and makes the return more difficult; but exercise and friction are of particular use.

DCIX.

As the vessels pass through glands before they reach the heart, we find in those a minute division of the vessels, and then an opening into very small cells, in which the liquor for some little time has its motion diminished, is more out of the course of circulation. Hence we conceive that the glands of the lacteals and lymphatic system are much exposed to obstruction, and that this will more readily happen in the lacteal glands, ~~because~~ a greater quantity of acrid matter passes through them.

DCX.

By this division of the lacteal vessels in the glands, the reason appears why, after the breaking of buboes or scrophulous tumours, there is a

considerable discharge of watery matter, the flow of lymph into the gland continuing, which in these cases does not readily enter the *vasa egesticantia*.

DCXI.

By the anastomosis of the lymphatic vessels and lacteals every where, the small branches continually receive an addition from the neighbouring ones; and whilst many pass through the gland, others pass upon the surface, and therefore an obstruction may happen in the first lymphatic glands which a poisonous matter touches upon; but although the same poison be conveyed further, the glands near to the heart are not affected. Thus, with regard to the venereal bubo in the groin, the formation is similar. Not one within the body is met with, which is prevented not merely from the warmth of the part, but especially from the poison being diluted by the joining of the lymphatic branches from the inferior extremities, before the poison reaches the next glands. Keeping the same in view, the reason is afforded, why a stoppage in a single gland does not produce an edema in the vessels from which it is originally derived, a number of the vessels passing over the gland, and carrying on the absorbed fluid towards the heart.

DCXII.

From attending to the cause of the swelling of

AND DISSECTION. cccxlvi

those glands, a direction is offered in the cure; for, by knowing the cause of the venereal bubo, we endeavour to direct the mercury into the gland, by applying it as near as possible into the part receiving the contagion.

DCXIII.

In the same way we are able to determine the extent of the disease in cancer, by the swelling of the contiguous glands; to judge of the superior advantage of the inoculation in small pox, from the poison entering through the external parts.

DCXIV.

Structure of the Glands.

But, on leaving the vascular structure, it remains to examine more particularly the nature of the glands; and, by tracing the beginnings of the several ducts, to endeavour to determine whether the arteries communicate with these exactly in the same manner that they communicate with the circulating veins; and thus, that their ducts only differ from veins in this respect, that the end of the duct does not terminate in the heart, and that the liquor differs from the general mals; or, whether a receptacle bag, or follicle, be interposed. Are we to imagine that a branch, which excludes red globules, takes its rise from the artery, and terminates in an excretory duct, or that there is a bag or follicle interposed, into which the artery pours the liquor.

DCXV.

These are the two common opinions entertained by physiologists. The most ancient supposes, that in every excretory duct, at the beginning, there is a follicle; and, in proof of this, it is observed, that there are bags containing slime upon the tongue and in the first passages, and a hole in the side of it. In the amygdalæ there are also several holes which lead to bags of considerable size. Hence the amygdalæ have been compared to a collection of small bags, and the liver and the salivary glands have been supposed to be composed of a number of knots, in each of which there is a bag of the same kind; but from the vast number collected, there seems a necessity that those should not terminate by holes, but there must be long ducts, like the hepatic duct, to convey the liquor. And in morbid bodies, also, vesicles are found in the liver, and also within the kidneys; and those are alleged to contain urine. So it has been conceived, that some one of the follicles of the kidney had been obstructed, and had enlarged, these vesicles shewing the real structure, only in a greater size. *

DCXVI.

When the art of injecting was improved, it was pretended that it was unsafe to reason in that manner from the analogy of one organ to that of another; and that, by injection, all the glands

could be changed into vessels, without leaving any appearance of follicles. It was alleged, that in the kidney the circulation might be imitated, and a coloured liquor made to pass into the pelvis; and yet, upon examining the kidney, no bags could be seen; or that, by injecting the renal artery, the tubulus uriniferus may be filled without any follicle found. A calculation is entered into, that, in the case of follicles, there would be an almost total stagnation of the fluids in the passage; that the velocity of the blood would not be 1,200,000 part in one of the follicles that it is in one of the arteries that is supposed to make the secretion. From this it has been inferred, that the glands are merely composed of cylindrical vessels.

DCXVII.

But to fix these points, we shall be more particular in our investigation of the glandular organs. Beginning with the fatty bags, we observe with the microscope, that the whole fat of animals, not only the marrow, which was supposed to consist of round fatty bags, but the fat is all divided into bags of a minute shape, painted with vessels, so that bags or follicles in that glandular organ are indisputable. Besides, all anatomists admit of follicles where the air, or sharp liquors are applied, and a defence is needed, as in all the mucous and lymphatic organs. In these follicles the mucus acquires its proper viscosity, or other properties;

fo the whole of the tongue is made red with an injection, and the bags of the follicles give it this redness, numerous arteries running upon them; and in the passage for the urine we find bags of a considerable size. In our throat, round bags answer as well as any other shape; but in the urethra they are oblong, and thereby the liquor is better pushed out at its extremity before the urine comes in contact with it.

DCXVIII.

Next, in the organs of generation, particularly in the ovarium, we perceive a round vesicle filled with a liquor, no doubt of the highest importance. This vesicle opens at the time of conception, and it is painted with vessels, and we find in the male long tubes forming the testicle, that the semen is deposited into these, and the communication of the arteries with the turns of the seminal ducts may be compared to the communications between the arteries and ducts of the intestines.

DCXIX.

With regard to the more compound glands, the structure of them is more like to the shape of a bunch of grapes or currants. ~~All the ducts~~ begin from bags. We see with the naked eye this structure in the mamma. We likewise observe little lobules composed of cells on the surface of the lungs; and in the salivary organs, we know as certainly as with regard to the lungs, that the

saliva is deposited into cells. When the salivary gland is properly injected, and exposed to the microscope, the appearance is nearly the same which the surface of the lungs has when exposed to the naked eye, and every one of the little lobules are distinct from one another. The joining, however, of the receptacle with the duct, is very straight, and it is difficult to fill the receptacles of the saliva with mercury, generally the duct will burst before the mercury distends the receptacle. With melted wax, which is a more penetrating substance, we can fill them more readily. In the parotid gland we find some little difference in the size of the receptacle, and in the manner of communication. In the pancreas, the structure is more complex, and perhaps the saliva is not the same; but as there is some difference of structure, the particular texture may be of greater consequence than we are aware of.

DCXX.

Next, with regard to the liver, the divisions are so minute in this organ, that it is next to impossible to determine the first beginning of the biliary ducts, because the lobules are very much intermixed. But as we have it in our power to dilate the ducts, we see that the biliary ducts begin likewise from very minute bags, such as the naked eye does no ways take in. But suppose they equal the thousand part of an inch; still they

are large, compared with the arteries making the secretion; for three or four thousand arteries conveying red globules could be laid in the space of an inch, but an artery circulating red blood is larger than one making the secretion, suppose four times, so that the diameter of the secreting branches is to the vesicle as one to twenty. And it is easier to pass an injection from the vena portarum into the biliary duct, than the other way.

DCXXI.

With regard to the kidney, the course of the fluids may be seen through it into the pelvis; but the more we are used with microscopical observations, we see the more difficulty in determining it exactly.

DCXXII.

Thus it is very evident that all, or almost all, the glandular organs have receptacles interspersed between the arteries making the secretion and the excretory ducts.

DCXXIII.

But although we can trace the structure of glands back from the excretory duct to the follicle, we are by no means able to give an account of the changes that are operating; and even did we know the way in which the arteries communicate with the follicle, we will be still far from understanding the changes made upon our blood.

by the glands. Thus, we can trace the whole course of the red globules of the blood, and yet we cannot see how these are formed from the food. It is effected by the general circulation; but with regard to the particular manner, we certainly do not comprehend it.

DCXXIV.

In speaking of secretion, we must include a variety of circumstances; and, perhaps, after enumerating all that occur to us, others still remain, the effects of which escape us. We see that the arteries of the glands are placed in very different situations with respect to distance from the heart, and the direction varies greatly; some going off at acute, others at right angles. There is, besides, a great disproportion in the size of the arteries compared with the organs on which they terminate, in their length, &c. We cannot but suppose that those various circumstances have great effect. The coats of the arteries are also of different thickness. In the liver, the secretion is made from blood that has undergone a circulation, and the force of which is more broken than in any other part of our body; so that long before blood comes near to a gland, or to the ultimate termination, a proper preparation is made for the secretion. Besides the effect of the different angles, we must also suppose the activity of the vessels to have effect; we observe that irri-

tation varies the quantity, and even the nature of the glandular liquors; and we are not, with authors, to conceive mechanical changes, as that the glands represent sieves, that the secretion and changes depend upon the ultimate terminations of the vessels. There are also chemical ones going on from the first origin of the branches, as well as in the termination of the arteries in the follicles. By fermentation, we know that the same substance puts on a different nature, and some similar changes take place in the glands. Therefore, though we were able to trace the arteries from their beginning to their termination in the ducts, of the glands, we should be unable to explain the changes we observe. We can go so far, but there is a limit beyond which we cannot pass.

DCXXV.

Nervous System.

We next proceed to consider the general office of the nervous system. In beginning which it is necessary to give some general idea of the manner in which some of the more powerful medicines act upon the body of animals; viz. whether they affect them through the nerves only of the part to which the medicine is applied, or whether they operate by entering first the absorbent, and afterwards the circulating system? We are, indeed, variously affected by medicines,

by the matter of disease acting upon our body; for, besides topical medicines, which scarcely affect the parts at a distance, medicines by resting merely upon a single nerve, through the nerves alone can affect the whole system, or from being circulated they may have this effect, and chiefly upon the nerves of the circulating system. Farther, we find that some medicines have a topical determination, or one organ is more affected by them than another; all the rest of the system, however, though not primarily, comes to be affected, re-acting on the rest. Thus, suppose mercury to enter the heart and vessels; they feel its influence, the pulse is affected before it fixes upon any organ, and the venereal poison is killed floating in the general mass; but in consequence of its attacking a particular organ, all the rest may come to sympathize: so the operation of medicines fermenting and multiplying in the mass, may be more complex than is generally apprehended.

DCXXVI.

With those facts we are better able to judge of the nature of the nerves. The manner of their origin and course is already known. A nerve is the production of the medullary substance of the brain, covered nearly with the same coats as the brain; an inner vascular one, resembling the pia mater; and an outer sheath, either the same altogether, or very like to the dura mater. This

is found in every part without the head : with the exception of ganglia, the threads of the nerves are laid parallel to each other. By dissection, a very minute division of the nerves is seen into threads; but applying the microscope, that division is carried on as far as our senses go, especially if we trust to the observation of Lewenhock, almost *ad infinitum*. Hence we are led to consider whether the nerves are to be looked upon as solid chords, like wires, acting by tremor; or are we to suppose that they are hollow tubes conveying a fluid within them? Or, are we to imagine, perhaps, that whilst they convey a fluid within, they in some other manner unknown conduct some other fluid that is still more subtle. But, perhaps, with regard to these several points, we can only form some very general conjectures, without being at all able to determine ourselves.

DCXXVII.

The most common opinion rejects the idea of solid chords acting merely by vibration, and there are many circumstances which concur against this notion. We have seen that the nerves are extremely short at their origin; if they appear hard in their progress, that depends evidently upon their coats. Again, when they come to operate, as in the eye or ear, we perceive that the coats are laid aside; nay, if the nerve is not to be sub-

ject to motion or pressure, as the portio mollis of the auditory nerve, the firm coats are altogether wanting; and we find so many nerves inclosed in the same bundle, that we scarcely have any idea of tremor communicated to one without communicating it to others; we find no determined proportional length and tension; on the contrary, tension is avoided, branches are tied down, preventing the regular tremor; and what is stronger than all this, such an idea is repugnant to the general analogy of animal bodies. Wherever we perceive fluids circulated, and chords sent out, these are tubular; and we observe that the most minute thread, the smallest nerve taken from one animal, and tied around the nerve of another, so as to compress it, altogether interrupts its influence: so there is little probability that the nerves, if solid chords, operate by tremor.

DCXXVIII.

On the contrary, there seems to be a great degree of probability, but no absolute certainty, that they convey a fluid. We can determine nothing from looking at the cut end of a nerve; we can give no credit to those who pretend to have seen a fluid distilling from a nerve, nor are we to reject the idea, because it cannot be seen, since the nerves divide into parts so minute and colourless, that if they contained a fluid, we could not render that an object of sense. We

might as well deny fluids in the body of a mite, because before a microscope we do not see the motion of thole; and the nerves of the eye, for instance, divide into parts exceedingly minute, far beyond what we could conceive, till we made a calculation, which we can make with tolerable accuracy. If the head of a pin can be distinguished at the distance of twelve feet, the diameter of the figure upon the retina is as much smaller than the head of the pin, as the distance from the pin to the lens is greater than the distance of the lens from the bottom of the eye. And entering into a calculation in this way, it is easy to prove that pictures are sometimes formed, the diameter of which does not exceed the 20,000 part of an inch; and probably that picture influences several nerves, because we can judge of its parts, that one part is more round than another. Thus, perhaps, in the retina, the nerves are not the 50,000 or 100,000 part of an inch in their diameter, and it is impossible to perceive their cavities, or the fluid they convey; so are to judge from probability, or by reason, upon it, by comparing the brain with other parts, or attending to the phenomena of the nerves.

DCXXIX.

The brain resembles some of our glandular organs in its appearance; we may compare it with the kidney. There is a vascular and cortical sub-

stance within that in the brain, what is called medullary substance, and the same name has been applied to the tubular uriniferous part of the kidney; and perhaps the nerves may be compared to the tubuli uriniferi, or at least there is a distant resemblance between these organs and all the other organs that have the appearance of blood distributed upon them, and that send out hollow tubes or ducts.

DCXXX.

Pressure upon the brain, though not so made as to destroy its substance, has been found to bring on convulsions of the muscles. That, however, is merely a probable argument, that something is squeezed out; but it may be occasioned many ways, as from irritation to a certain degree. But we know that moderate pressure upon a nerve stops its influence, as when we sit upon the edge of a seat the whole leg sleeps; and, when we remove the pressure, we feel a somewhat get into the member, not without pain; we are almost afraid to rise off the seat, as if something had been accumulated, and immediately descended into the nerve with more than common violence. Or if a nerve is laid bare, running to a muscle, then the nerve cut across, the muscle becomes unactive, but may be roused into action by puncturing it; but there is another way, by moderate pressure upon the nerve. If we press it in the

most gentle manner, without stretching it, we are sensible of a motion following, as if we had determined somewhat from the nerve down into the muscle. So that the most probable opinion is, that the nerves convey a fluid. Still, however, we are very far from being certain of this, because every circumstance may admit of some other explanation, and is only mentioned as more probable than any other opinion yet formed.

DCXXXI.

How far we are to add to this, that whilst the nerves convey within them a fluid, they are likewise charged with some other without them, or in their coats.

DCXXXII.

With these observations we are led to examine their more particular offices. They serve, as has been said, in general, for sense and for motion.

DCXXXIII.

That the two first offices are most justly assigned to them, is beyond all reasonable doubt; for, the most simple arguments prove it. When a nerve is cut, the animal suffers no injury, no pain, from irritating the member beyond the incision. In like manner the member loses the living principle of the animal, it loses all further power over the member, the animal has it not in its power to perform any motion with the muscles of the part, suppose the circulation to continue much as before.

DCXXXIV.

But now let us consider these two offices of sense and motion more particularly. Physiologists, in general, use an improper term. Speaking of nerves, they call them the only sensible parts, that the nerves only possess sense. But meaning to define with precision, it may be said only, that the nerves are so disposed in the body of an animal, as to give to it the sense of injury done to the body. We are not to imagine that we feel pain, but the nerve only gives the idea, or renders the mind of the animal, seated near its origin, sensible of the injury.

DCXXXV.

It is material to attend to this, because we perceive that, from want of attention, some appearances surprise us, which admit of a ready explanation. If a person has had the leg amputated, and you irritate the end of the stump, the end of the sciatic nerve, he feels pain, but not in the thigh or stump, but the toes, in that part in which the nerve naturally terminates. And in doing this, he follows not merely a habit, but that such feelings are inherent in our very nature; and if the same experiment were performed in the foetus, it would be attended with the same effect. So physiologists have used a term of sensorium commune, some part about the origin of the nerves, in which feelings are exercised.

DCXXXVI.

One great difficulty is to be able to acquire an idea of the manner in which the nervous energy can produce its effects, which leads next to enter upon the nature of this energy, and particularly whether we are to imagine that it is derived in the manner of a secretion from the vessels of the brain or cerebellum, or that it is of a very different nature, similar to the electrical fluid, or to the fluid named ether, or that it is some fluid very different from this, the properties of which we are perfectly unacquainted with?

DCXXXVII.

Of late years, many ingenious physiologists, from not being able to conceive the manner in which a secreted, call it a watery fluid, should perform sense and motion, have adopted the idea of an æthereal matter, or electrical fluid, acting along our nerves. If our nerves of sense and motion operate by means of an electrical fluid, or an ætherial, what is the use of the brain and cerebellum? If we admit the other idea of secretion, the use is obvious. Are we to compare the brain to an electrical globe exciting this fluid? It is surely by a gross comparison. How next does the matter pass along the nerves? How is it prevented from communicating its influence from one thread to another? Why does it not escape from the nerves, as the electrical fluid passes

through the body? So far as they are loaded with a watery fluid, we do not find that they are more capable of conducting such a matter, than any other portion of the body equally wet. If the brain some how or other excites this fluid by the blood moving through it, the more a person exercises himself, the less he should be fatigued, more of this energy being excited and collected. Or how does a slight pressure upon a nerve stop the energy? The pressure is made with any kind of substance as with a nerve taken from another animal, and tied round so as not to injure its texture, and the energy totally ceases. On cutting it through altogether, and replacing the nerves, bring the parts in contact, all influence ceases: or separating a member, and allowing time for the escaping of such a fluid, we still find the energy remains. Instead, therefore, of solving the old difficulties, we seem to be adding to them; and though it is difficult to conceive how any watery or secreted fluid performs the office of nerves, yet it is as well to be conceived when we substitute some other very penetrating and elastic fluid. Do we conceive better of the action of the muscles from a deluge of electrical fluid rushing in upon it, or some other secreted matter? Or do not we see that changes equally wonderful are produced by secreted fluids: the body is formed, the generation of animals depends upon it, we understand

not how, but we cannot deny the fact; so, upon the whole, all we can say is this, that it is the most probable opinion, though far from being a probability next to certainty, that there is a fluid in the nerves; far less can we form the most distant idea of the nature of that fluid, or of the manner in which the mind of animals operates upon it. Nor is it reasonable to expect that the nature of it should ever be understood; if it serves to connect the material and immaterial parts together, as we are ignorant of the nature of mind, we shall be for ever ignorant of that chain by which mind and body are laid together. Having knowledge, so far as experiments will allow, of the nature of the nervous energy; for it is as much a point of sound philosophy to know where to stop, as to know when to proceed.

DCXXXVIII.

With these remarks on their offices, we next trace the nerves from their beginning to their termination, observing the use of every part. In doing this, their coverings first claim our attention. The dura mater defends the brain, and where the nerves are sent off gives a covering to them; is produced without the head with them, or somewhat of the same general nature with the dura mater accompanies them in their progress, and this is evidently for their defence. That the dura mater in the arm serves the same

office to the nerve as to the brain within the head. We need no other proof of this, than the comparing the first pair with the second. The olfactory entering through holes into the nose, needs no sheath; but the second pair passing to the bottom of the eye, and exposed to the action of the muscles of that organ, needs the sheath. So, with regard to the seventh pair consisting of two branches, the portio mollis within the os petrosum wants the sheath, while the other portion without receives the dura mater. Or, tracing a nerve to its termination, as the optic nerve into the retina, the dura mater is again laid aside: so we are never to connect the office of the nerve with that of this coat.

DCXXXIX.

Next, we meet with a coat of more consequence, the pia mater, which covers the whole surface of the brain, entering into all its convolutions, and from the membrane there are branches plunging into the cortical substance, and that is connected to the medullary; so that we have no instance of a cortical matter that does not produce medullary; or we find no medullary substance that cannot be traced back to cortical. So we conceive that the pia mater is a membrane of the utmost consequence to the brain, though no author has applied what he observes with regard to the brain, to the nerves in their progress.

Now it would appear that the pia mater, in the whole extent of the nervous system, furnishes to the nerves in their progress, what it does to the brain at their origin. For, first, we observe in the spinal marrow a cortical substance, a cineritious matter. Now, surely, the spinal marrow very much resembles any of its branches, dividing farther, so we may look upon it as the principal nerve of the body; that, whilst the chief part is the production of the brain and cerebellum, an addition is made to the nervous energy or matter. And we have reason to believe that the case is the same with every other nerve; that as the surface of the spinal marrow over the medullary part is cortical, so that every nerve is cortical. Compare the whiteness of the medullary substance with the threads of the nerves after they have left the brain, they are of a brown ashy colour, the threads lose their whiteness, and appear to do so after we have separated as much as can be done of the pia mater from them. The want of brain, also, in many animals, is natural; and in the human body, where the brain has been wanting, the same kind of coats of the nerves have been found, and not very much smaller than if the brain had existed. Hence we would infer that that power we ascribe to the brain, may be in supplied by the nerves, we feel only by a what about the origin of the nerves, but a

nervous energy roused in the nerve can actuate a muscle. Or let us attend to the effect which stopping the circulation in the vessels that accompany the nerves has. According to the common idea of the nerves being derived from the brain, the stopping the circulation should by no means have the great effect of preventing the nerve from communicating its influence backwards to the rest of the system. If the femoral artery is tied, though we apply opium to the inferior extremity, so as to bring on the want of motion, it is not communicated through the nerve unless the circulation is free along with it: so we shall be tempted to imagine that the use of the pia mater is much more extensive than is supposed, and that this vascular coat serves more important purposes than the merely conveying nourishment to their coats.

DCXL.

Hence the diseases of the nerves may depend more upon topical causes, and be more remedied by medicines confined to the part than we are generally taught to believe. In most affections of the nerves, the disease can be traced to the head, but we may suppose considerable diseases to take place from the want of a due circulation along the nerves in their course or progress. On going deeper, we find the medullary part of the brain every where intimately connected with the cortical. We find, again, that the nerves coming

from the medullary part, are evidently the continuation of its fibres; and we can trace the threads of a nerve a certain way into the medullary substance of the brain. But we are by no means to conceive that the brain serves only to form nerves for sense and motion; there are other latent and important functions performed, we would be inclined to think so from observing the various directions of the threads in the medullary substance, from the much greater bulk of the brain than of all the nerves. We find many bundles of medullary fibres directed to opposite sides of the brain, and not to the beginning of the nerves. On comparing different animals together, we find upon the whole that the brain and the degree of sagacity, vary in some kind of regular proportion. In man we find by much the largest brain proportioned to the size of the body. In the quadruped, the brain is larger than in the bird. In the bird it is larger than in the fishes.

DCXLI.

Wherefore functions of which we can give no explanation, are better exercised by a certain modification of the brain, or the powers of the mind, by a certain modification of it, seem to be expanded. We cannot help drawing a conclusion of this sort from merely considering the more obvious circumstances.

DCXLII.

In tracing the nerves from their origin to their termination, we are next led to observe the effects of connections among them, whether within or without the head.

DCXLIII.

There appears no room for imagining that the office of the brain and cerebellum are essentially different; that the one serves for the animal, the other for the vital functions. For we find that the 1st, 2^d, and 3^d pairs are derived from the brain, so the 4th and 5th from the cerebellum; but that the others are derived from the medullary substance of both intimately united. Next, let us confine our view to the origin of a single nerve: in a few places we can perceive that the nerves are united to both sides of the brain. This is more particularly remarked of the optic nerves; but in man, as well as in other animals, we can trace them to both sides; but, if we are to judge from the disposition of most of the others, we would suppose that they take their rise from one side only; yet plain observation seems to prove, that almost all our nerves have a double origin. For if the right side of the brain be injured, from Hippocrates down to the present time, it has been observed that both sides of the body are affected, and it is difficult to determine which side suffers the most. On taking this in a general way, we

find the origin of our nerves to be more extensive than at first sight we are apt to suspect.

DCXLIV.

Now, pursuing them from the head and spine, in many places they are connected; and, upon the whole, the connections are of three different kinds.

DCXLV.

To begin with the most simple. In the axillary plexus, or in the nerves that are to supply the inferior extremities, there is a joining of two or more nerves into one bundle, the cord they compose being equal in size to those which enter into it. After they run some way, they are again separated, or we see new cords formed.

DCXLVI.

Suppose, next, that a couple of muscles are to be supplied with nerves, we find a division; and it is in this way that each muscle receives branches from each of the nerves, or that the first nerve supplies the first and likewise the second muscle, and the second does the same.

DCXLVII.

Another kind of connection appears, for example, in the face. We see nerves coming out of holes at a great distance from each other; and, after spreading into threads, these are connected together in a way representing the anastomoses of the blood vessels. Opening the sheath, the same

things seem to happen as in the former anastomosis, at least, so far as we can judge of minute nerves, there is a crossing of threads, and no interruption of the threads at their union. The intention of this is, that if by any accident a nerve in its progress happens to be cut or compressed, all the muscles in which that nerve terminates may still preserve some share of their power.

DCXLVIII.

But a third kind of connection is by means of ganglia. We find a number of nerves, as these between the vertebræ, running together, and where they meet, a great increase of bulk, or a knot, is produced; and from the opposite sides of that we find distinct threads again sent off, in some instances nearly of the same size; but in others larger than the threads which enter, and more numerous in their appearance; and tracing the threads through them, they change their colour and appearance in every respect. The ganglia are redder than the nerves, resembling the colour of a lymphatic gland; and it is as difficult to show threads running parallel to each other through a ganglion, as to shew threads in a conglobate gland, the substance appears compact: so we are much at a loss to determine the nature and the use of ganglia. The threads, indeed, of the several nerves are here more intimately intermixed than in the former connections, and there may be other latent pur-

poses which they serve, such as have neither been proved or conjectured. Some authors consider the ganglia as muscular organs serving to push on the nervous fluid, whilst others consider them as forming an additional nervous influence. Others again suppose that a more intimate communication is made here, that the fluid is poured out into certain receptacles, and again conveyed to all the branches; and, of late years, it has been asserted that the ganglia are interposed to intercept the power of our will, and therefore to render certain motions of the body involuntary, such as that of the heart, because it is evidently unsafe to trust the management of the heart to our discretion. But, though this opinion is supported with ingenuity, yet many reasons enforce its rejection. Indeed, the distinction made of our actions into voluntary and involuntary, is by no means proper. The action of the muscles is involuntary; we direct our arm to a certain object, but we have not the direction of our muscles employed for that purpose. Next, the ganglia are not confined to muscular organs; we have seen them in many of the glands, and in many of the muscles, which are clearly voluntary, and every one of the muscles of the extremities and trunk of the body is supplied with nerves that pass through ganglia. Besides, all the spinal nerves, before they come to the axillary plexus, pass through ganglia.

DCXLIX.

But this leads on to a more general point, to determine the cause of sympathy among our several nerves; and the reason and manner in which the variety of muscular motions is performed, whether this depends merely on mechanism, or is directed by a wise agent. In considering sympathy in the literal sense, we find that an injury is transferred from one part of the nervous system to another, or to the whole system. We perceive that if any organ of the body is violently irritated and inflamed, the irritation spreads more readily to the neighbouring than to the distant organs, owing to the connection which the hydraulic system has with the nervous, the one acting and reacting upon the other. But we must likewise admit that if a branch of a nerve be violently irritated, the irritation or inflammation will more readily disorder others confined in the same sheath than the distant nerves of the body; and sometimes we meet with plain examples of that kind, though not very frequently. Thus, if a tooth be carious, the irritation extends along the several nerves inclosed in the same sheath with that; and we find if the irritation is in the incisores of the right side, that that side will more readily suffer pain and inflammation than the opposite side. Nay, it is evident that there is some latent mechanical connection of the nerves of one side of the body

with each other, producing remarkable effects. We see frequent examples of hemiplegia, where one side of the body is affected with palsy, while in the other the muscular power is preserved, which must be owing to some immediate connection the nerves on one side have about their origin, or in their progress.

DCL.

We observe, also, a general connection of all parts of the nervous system with each other. Thus, if we touch the sciatic nerve with a drop of hartshorn, burning the nerve will not kill the animal, but the slightest application of this will. So, in the case of a bite of a rattle-snake, from the connection of the nervous system, all the parts sympathize.

DCLI.

But does it follow that the variety of regular motions of our blood depend upon mechanism, whether from the connection of the nerves in their progress, or origin? Or, to explain the question, let us suppose an irritation applied to a particular organ. Suppose that the nose is irritated by any acrid matter, we sneeze in consequence of that. Now, how are we to account for this action, which is abundantly complex? Are we to say, as generally has been done, that we can trace the connection from the nerves of the nose, to those that regulate the motions of the

diaphragm and abdominal muscles, and from that connection are to explain the action following the irritation. Thus, the first branch of the 5th pair sends the nasal twig to the nose, the second branch of the same nerve supplies the beginning of the great sympathetic or intercostal nerve, or, running down from the head, is connected to the several dorsal nerves, in its passage along to the phrenic ones, which regulate the diaphragm, &c.

DCLII.

Many arguments occur against such an explanation. We have a sense of injury before any action ensues; or, if we are to consider this opinion in a general way, we find many objections arise against it.

DCLIII.

If a nerve, when irritated, immediately throws into action all others connected with it, when we irritate a nerve of the fore arm for instance, laying the nerve bare that it may act more readily, it should draw the muscles inwards; but we act with different muscles pulling the arm away. Or, how comes it that the intermediate muscles with which the nerve in question is perhaps more connected, are free from action? Why do not the several muscles of the face and neck act as violently as those of the diaphragm and abdominal muscles? Or, whence the regularity of their action? Or, why does not an irritation applied

to other nerves, as a wound of the neck, immediately produce sneezing, in like manner as the irritation of the nerve within the nose? May not we trace the sympathy in the reverse way? Why does not the farther end equally influence the beginning? Or tracing the intercostal nerve through the body, the motions are varied according to the place. If the nose is irritated, we sneeze; if the throat, we vomit; if the irritation is within the breast, or if there is a want of that somewhat necessary to life, as in over-heated air, our breathing is affected; but where, with the air, an irritating substance is conveyed into the trachea, we cough; so a similar irritation applied to the same place, produces a different action. Thus, with regard to the irritation within the abdomen; if it is in the stomach, we vomit; if in the guts, purging is excited; if the irritation is in the uterus, there is a certain effort; if it is in the rectum and vesica urinaria, there is an effort of a different nature; and surely this variety cannot proceed from mechanical principles.

DCLIV.

On the other hand, the same regular motion follows, where we can trace no connection. Do not we act with the iris, though the irritation is applied to the 2^d pair, at the bottom of the eye? Nay, the two sides sympathize; the two eyes move in an uniform manner, which is not

from any connection with the optic nerve. And we are all sensible, that almost every action or impression first influences our mind, the *living principle* is roused, and the action follows it; or the imagination, in time of sleep, performs similar operations where the stimulus is absent. Therefore it is evident, that we cannot ascribe these regular motions to mechanism, and must give some different interpretation of the matter.

DCLV.

In order to do this, let us review the principal actions in a general way, and observe the reason of the effects. Let us begin with those where the irritation is at a distance from the acting organ. If an animal hears a confused sound, he expands the ear, and directs it to the sonorous substance, and the motions of the deep parts must follow those of the external; or we observe the accuracy with which the eye adapts itself to light, or with which the two eyes meet to examine the same object; or in sneezing, coughing, &c. we perceive the motion varied according to the kind of irritation and effect which the motion may have in removing it. If a quantity of blood rushes into the lungs, no action is so fit for allowing it to pass as inspiration; or if we have too small a quantity of living principle from the air, or the air is too light, we inspire more frequently. If an irritating substance be confined within the trachea, we

cough, which is a very complex action, but the most effectual for throwing out the offending cause if the stomach is affected, and it is unsafe that the irritating substance should pass downwards; it is thrown back by vomiting, and that likewise is a very complex action, performed by means of nerves derived from very different sources; or, if the acrid substance gets into the intestinal canal, the increased action of that is excited. If the irritation is in the bottom of the canal, besides the increased action of the coats of the intestines, we bring into play the pressure of the diaphragm and abdominal muscles in a regular manner, pressing steadily, and with considerable force. The same thing happens in delivery, and in assisting the bladder of urine to throw out its contents, and to open its mouth.

DCLVI.

If the bladder is irritated, the motion produced is a gradual contraction, different from the action of the intestinal canal, which plays backwards and forwards, pushing the food down, bringing it back again, and applying it to the secerning vessels and absorbents. We have the power over that, though the bladder is supplied with nerves through ganglia, we can stop the action of the bladder, or increase it, at pleasure.

DCLVII.

If we next apply a stimulus to the muscles of

our extremities, other muscles are thrown into action, while the arm is held fast, and the injury kept applied, the muscle vibrates, as the only way it can free itself; and this has led physiologists to talk of muscles being disposed to contraction and relaxation. They are in no shape disposed to that state; do not we see the contrary in the bladder of urine? They only perform that action which is most fit. We see the heart subjected to an alternate contraction and relaxation, as that kind of motion is most fit, the heart throws itself into its utmost action in an instant, because an action approaching to the *vis percussio* is necessary to drive the blood through the vessels; and the same contraction in the bladder would have been hurtful, without any purpose being served by them: so these actions are regulated by a wise agent, and it only remains that we determine the agent.

DCLVIII.

In that circumstance authors fail, and their views are greatly limited. An attempt has been made to persuade us that our mind reasons upon all these actions; and after holding consultation with herself, determines the manner in which they ought to be performed. Whilst others would persuade us that these actions are dependent upon our mind; but from a necessity, not from a choice, the heart is stimulated, and the mind forced to

interpose; otherwise the heart would be burst, therefore it obeys the stimulus, and contracts.

DCLIX.

Now it is perfectly clear, that we cannot reason upon such actions, because we want data. We are ignorant of the facts upon which reasoning could proceed. We are not born conscious of our structure, and we cannot be said to do any thing from necessity which is beyond our power. Let us only take in a few actions, where the operation will be allowed to depend upon some other principle. An infant, the moment it is born, breathes as regularly and in as proper a manner as an adult. It sucks, and swallows regularly what it receives into its mouth, and all this upon the first trial, as well as upon the last. By what power can that be done? Surely we would say, by instinct; and by this we understand a power that existed before we existed. Can we say that our mind, that we ourselves possess a voluntary power over our muscles, and yet are nowise conscious of the number, or situation of these. If we were, anatomy would be a needless study; but we know nothing of our muscles; all our power is, that we wish to move a member in a certain manner, to lay hold of something, and we are conscious of that action, and do it readily, but we know nothing of the regulation of the muscles about it, it is done for us, so all mus-

cular action is involuntary. Nay, shew any muscle in our body to the most able philosopher; desire him to act with it, he cannot do it, unless you tell him the motion; then he wishes to perform that motion, and the action of muscle follows the wish.

DCLX.

So the more we consider the actions of animals, we find the greater reason to conclude, That the *Author of Nature*, who made and created them, continues, with *His* unceasing influence, to operate upon them, not by particular, but general laws, in such a way as is most fit to maintain them.

DCLXI.

Anatomical Preparation of the Vascular System.

To exhibit a full view of the vascular system, a young emaciated subject, not exceeding the age of 14, is preferred, and is even preferable if anasarctous. To prepare for the injection, an incision is first to be made through the teguments the whole length of the sternum, equally dividing the bone longitudinally with a saw into two. Under the divided bone, a knife is to be introduced on each side, separating the mediastinum; then by bending back the sternum and cartilages, the thorax is laid open. The next step is to make an incision into the pericardium and left ventricle of the heart, and through the latter a pipe is to be introduced into the aorta ascendens, and then secured by ligature on the vessel. The body is then to be immersed in hot water, as directed in other cases, and the injection conducted

also in the same manner. The injection being finished, the body is to be laid with the face downwards in cold water to cool the injection as soon as possible, and keep it equally diffused in the vessels, without separation of its colouring part.

The injection being thus finished, the dissection next follows, which is conducted by first opening the abdomen, continuing for this purpose the incision from the thorax to the pubes, and then removing the thoracic and abdominal viscera. The stomach and intestines are next removed by cutting the mesentery close to the latter, so as to leave as much as possible of the mesenteric arteries. The liver is next dissected, leaving as much as possible the ramifications of the hepatic artery. In the same manner are the kidneys treated, or they may be left to dry, and the spleen is removed with the stomach. All the vessels left should be freed as much as possible from extraneous substance, in order to render them distinct. The bladder of urine may be inflated, and preserved whole with the rectum, and its connecting membrane should be removed from the pelvis, so as to bring the internal pudendal artery into view. In dissecting the abdominal viscera, care should be taken of the spermatic arteries from their length and slenderness. The thoracic viscera are easily removed. The heart, lungs, and œsophagus, are to be entirely removed, and the thoracic vessels rendered by farther dissection as conspicuous as possible.

The divided sternum, in order to show the internal mammary arteries arising from the subclavians, should be bent back, and to effect this, the cartilages of the ribs should be partly cut on the inside.

The subclavians, carotids, &c. should be made conspicuous, and their ramifications traced over the head with much time and patience, and no more of the skin should be raised from any part at a time than is necessary to carry on the dissection, to prevent exposure of the subject to the air and its drying; and in using the knife here, the edge should be kept to its inner surface.

In tracing the blood vessels, it should proceed from the large vessels to their ramifications, and the dissecting scissors and forceps are the instruments used after the raising the skin. The natural shape of the cheeks and lips are to be preserved by filling the mouth with tow or wool. Then the extremities may be dissected. First, in the arm, after raising the skin, trace the vessels from the axilla to the ends of the finger; and in the lower extremities from the groin to the toe. Separate, also, and raise the muscles cautiously from each other, removing the fat and cellular membrane every where, without removing their attachments, except where the course of the vessels cannot otherwise be shewn, as on the side of the neck, and at the transverse processes of the vertebræ. The pectoral muscles should also be raised; the glutæi elevated, or partly removed; and the muscles of the dorsal and lumbar vertebræ on each side should be taken away, in order to facilitate the drying of the subject. The brain should also be removed through an opening in the cranium, as formerly described.

The dissection being then finished, the body is to be suspended in a cool free air by a cord from a hole in the summit of the cranium. The muscles are then to

be separated by the intervention of wool from each other. The thorax and abdomen are to be divided in the same manner; and in doing this, regard is still to be had to preserve their situation, and to prevent the appearance of distortion. The mesenteric, and other vessels, are to be placed in proper positions. The same attention is to be paid to the situation of the legs and arms, with the same view of shewing the vessels. The one hand may be elevated over the head, the palm inclining forwards; the other may hang down perpendicular, with the palm forwards. The inferior extremities are bent in their natural position. Much attention is necessary to preserve these positions during the dissection, and to avoid the putrefaction of any part which, if appearing, should be washed off with spirits, and a painter's brush. The preparation should be immediately varnished.

Anatomical Preparation of the Nervous System.

For this purpose a small subject is preferred. The dissection is begun by an incision through the skin from the lower part of the fore head, over the head to the occiput; and turning down the scalp on each side with the view of removing a circular piece of the cranium with a saw. The brain is then to be taken away, cutting the nerves in removing it close to the organ, and gradually proceeding from the 1st to the 10th pair.

The olfactory, or 1st pair, being too tender for dissection, the optic are to be shewn by making a section to remove the upper part of the orbit. By this should be shewn the distribution of the branches of the 3^d, 4th, 5th, and 6th pairs, contained within the orbit. After

tracing the remaining branches of the 5th pair, they follow by the superior and inferior maxillary branches, dividing the lower jaw at its symphysis. The inferior maxillary branches are traced, one to the tongue, and another to the angle of the lower jaw. The 8th pair is to be prosecuted with the intercostals from the base of the cranium into the thorax and abdomen, carefully dissecting all the branches. The branches of the 9th, 10th pairs are readily pursued to the different muscles which admit their ramifications.

iii. dissecting the spinal nerves, begin with the 1st. I trace its several branches before proceeding to the 2nd and so in the cervical nerves, the branches which form the phrenic, should be pursued and traced to the diaphragm. On completing the dissection, the subject is to be preserved in spirits.

PART III.

MORBID ANATOMY.

DCLXII.

OUR views have been now sufficiently directed to the state of the body in health. In this state it is seldom presented to the eye of the physician, and it is only under the influence of disease and derangement it becomes the object of his care. Morbid Anatomy, therefore, or the changes induced on the human system by disease, claim our principal attention, and the former part we have hitherto considered, is only useful in so far as explaining the latter.

DCLXIII.

In explaining this division, it is proper to alter the arrangement formerly observed; and instead of commencing our investigation with the basis of the body, we consider the parts in their order, as more or less essential to the continuance of life. On this plan we are naturally led to begin with the heart and its appendages.

DCLXIV.

Morbid Change of the Pericardium.

The pericardium, or covering of this organ, we find subject to various changes.

DCLXV.

Inflammation.

It is, first, liable to inflammation, though not so common, and when occurring, chiefly displaying itself in the adult state. By this attack it is thickened, becomes pulpy and more vascular, and upon its inside there is formed a layer of yellowish pulpy matter, easily separated. The extent of this layer varies, as also its degree of thickness. From the pericardium small vessels shoot into it, slightly reddening it, and frequently colouring it with small spots of florid blood. Projections are also thrown out from it at times, forming an appearance resembling lace-work. The whole of this matter much resembles coagulable lymph. With this state of the membrane there is accumulated in its cavity a brownish or yellowish fluid. It varies in quantity from a few ounces to more than a pint. It is mixed with loose pulpy matter, and sometimes also with pus. This fluid resembles the serum. The inflammation of the pericardium is generally communicated more or less to the heart.

DCLXVI.

From the layer of coagulable lymph inspissating, a new vascular congeries is produced; and by this

congeries a quantity of serum is poured out, and afterwards taken up by the absorbents of the same part as the disease recedes. Pus also is discharged from the arteries of this part, as there is no other source from which it can be readily produced.

Symptoms.

The symptoms of pericardial inflammation admit no distinction from those of the heart; and that organ always participates in the same state when the inflammation is violent. The most usual mark of it is general fever, or increased action, accompanied with pain of the heart, which is generally attended with palpitation, irregular pulse, cough, dyspnæa, and sometimes syncope.

DCLXVII.

'dhesion.

* This membrane is also subject to adhesion to the heart. Its extent varies from a few points to the whole surface, and the adhesion is formed either by a thin membrane, such as the cellular elsewhere, or a solid matter like coagulable lymph; and both are very vascular. These adhesions are always the effect of a previous inflammation; and the period of its occurrence may be judged of by the degree of adhesion, being loose in cases of old date, and firmer in the more recent.

Symptoms.

The symptoms of this state are not always

clear, except where the adhesions are close and extensive. They are then marked by oppression and pain in the situation of the heart, an irregular, and at times intermittent pulse, dyspnœa, and dry cough.

DCLXVIII.

Dropfy.

This affection is frequent in advanced life, though it may occur at every age. It is found by itself, but at other times accompanied with dropfy of the other cavities. Its quantity varies from two ounces to more than a pint; and whatever is the extent, no tenseness of the pericardium is displayed, which, perhaps, enlarges with the accumulation. The colour of the fluid is most frequently yellowish, and resembles in its properties the serum.

Symptoms.

Water in the pericardium much resembles the symptoms of hydro-thorax; but the feeling of oppression here is more strictly confined to the situation of the heart, which is also more disturbed in its functions; and this oppression will be also most felt when laid in the horizontal posture, though the two diseases are, for the most part, conjoined.

DCLXIX.

Dryness.

This membrane has been found occasionally like a dried ox's bladder, from a want of the secretion of its natural moisture; but it is a rare occurrence.

Symptoms.

The peculiar symptoms that mark this state are perfectly unknown.

DCLXX.

Tumours.

Small tumours have been seen growing within the cavity of this membrane. From their containing a white soft matter, with a curdled or cheesy appearance, they have been referred to a scrofulous origin.

Symptoms.

Where this appearance occurs, it is generally combined with a diseased state of the lungs; and when the tumours are so large as to disturb the functions of the heart, this disease will then be distinguished by similar symptoms as when its disturbance arises from other causes.

DCLXXI.

Hardness and Ossification.

The conversion of this membrane into cartilage is only very partial; and, in a similar manner, it is occasionally changed in certain points into bone, and the latter is more frequent and extensive in its progress than the former. This state has been marked by no peculiar symptoms.

DCLXXII.

Defect.

From a defect in the original formation, a want of this membrane has been met with; and,

in that case, the heart and its vessels are seen at once completely on opening the thorax. A close and uniform adhesion may be mistaken for it, but here the heart and its vessels do not come so readily into view, and an adhesion prevails at the same time to the tendinous part of the diaphragm; while, in the former case, the heart lies bare in the cavity of the chest.

DCLXXIII.

Symptoms.

This state is attended with no peculiar symptoms.

DCLXXIV.

Morbid Changes of the Heart.

The morbid affections of the heart may be divided into two kinds, those arising from mal-conformation or disease; and wherever this organ is affected, consequences follow greater than we can explain from mechanism. The patient has anxiety and oppression beyond description; a quick pulse, the consequence of irritation, but it is irregular and intermitting in various degrees; and we are to conceive those changes depend upon the sensibility of the organ, and the sympathy which the body has in general with it, and particularly the nervous system is considerably irritated.

DCLXXV.

Affections of Malconformation.

The diseases of malconformation are various, according to the particular part where the fault lies. The most frequent affection of this kind depends on a fault of the pulmonic artery; and this again prevents the closing of the foramen ovale. The blood, therefore, does not pass, or but imperfectly, into the lungs; it is merely sent from the one ventricle to the other through the foramen ovale; and in this state, without oxidation, it is transmitted into the aorta. If the blood passes in part into the lungs, life continues some time; but if not, the child generally expires a few hours after birth in convulsive struggles.

DCLXXVI.

The next affection of this kind is the commencement of the aorta over the partition of both ventricles, without its being particular to either, by which an opening or a free passage takes place to both sides of the heart. This conformation is also joined with a narrow or contracted state of the pulmonic artery. Thus the quantity of blood oxidated is merely what passes through this contracted vessel; and when returned to the heart and mixed with the mass, it is barely sufficient for prolonging a miserable existence.

this circulation large coagula of black blood
m. The size of the organ becomes considerably

enlarged, while the structure of the lungs decays and shrinks.

DCLXXVII.

A third affection of this class, is an additional cavity to the heart or middle ventricle, in which the pulmonic artery and aorta both begin; so that the right ventricle sends out no pulmonary artery, and the left ventricle no aorta. By this means, as all the blood is poured into this middle ventricle, only one half goes to the lungs, and the oxidation is therefore incomplete to that extent.

DCLXXVIII.

The symptoms of these various species of mal-conformation are marked by difficult respiration, blackness of face, which soon extends over the rest of the body; convulsions repeated at intervals, and general palpitation and throbbing of the heart, so as to be externally apparent to the eye. When some oxidation takes place, and life is protracted, the marks of imperfect oxidation are conspicuous by the dead or livid unhealthful colour, by the langour and want of motion, by the coldness and deficiency of vital heat, which nothing can remove; by occasional fits, by oppression and anxiety at the heart, by distressed respiration on the slightest hurry or action, and by the breathing being easiest in the fit, and the child acquiring relief by it.

DCLXXIX.

When the malconformation is in a less degree, the marks of this state often do not appear till some time after weaning, and when more oxygen than what the lungs can draw in is required for the wants of the system. There is always, along with those symptoms, marks of imperfect nourishment.

DCLXXX.

DISEASES OF THE HEART.

Inflammation.

Inflammation of the heart is rare, except when connected with that of the pericardium, and then the affection of the latter passes some way into its substance, which, in that part, becomes more vascular, and shews some marks of bloody extravasation. Inflammation, however, of the heart itself may occur; but it is hardly to be supposed, as has been alleged, that this organ can pass into abscess or ulceration, as death must take place long before

Symptoms.

Inflammation of the heart is marked by the same train of feelings that distinguish that of the pericardium. Syncope, however, will be more frequent here than in the former.

DCLXXXI.

Spot.

The surface of the heart often exhibits a white pale spot at one part, of various size, from a fix-

pence to three times the extent. Its most frequent situation is the surface of the right ventricle, though occasionally elsewhere. It seems an adventitious layer from the pericardium.

Symptoms.

It is of little consequence, and is therefore not marked by any peculiar symptoms.

DCLXXXII.

Polypus.

The next affection, the disorder termed a polypus, though it is not so frequent as many seem to conceive, is yet not to be altogether denied, for the blood does coagulate after death without the access of the air; so, if a person from terror, &c. has fallen into a faint, and continues for some time in it, we may conceive a coagulation to have taken place, consisting of coagulable lymph filling up some of the cavities, and extending to the large vessels, which is perhaps not to be removed, by the succeeding action of the heart; and where after dissection nothing is found but a very firm coagulum within the heart, this could not have happened *in articulo mortis*, and we may conceive that it happens here as in the case of aneurism.

Symptoms.

We judge of this by the cause, and by finding that the person in certain postures is more uneasy than in others, for the polypus may be situated so

as to cover the mouth of the ventricle, and may be removed by posture.

DCLXXXIII.

Enlargement.

The enlargement of the heart, for the most part, depends upon the ossification of the valves, particularly those of the aorta. This part is more subject to pressure, and therefore to this accident; for the blood is thrown through a narrow passage with violence, and the artery re-acting, the valves are shut; so they are subject to pressure both from the heart and arteries, and in most people put to hard labour, we find an ossification about the mouth of the aorta, and this disease in the human body is much more frequent than is commonly imagined. Its termination is sudden, for such persons die suddenly.

Symptoms.

The manner of distinguishing the disease is this: The patient feels anxiety, oppression, the pulse is irregular, generally intermittent, and for the most part weak. He complains much of heat about the breast, and perhaps this may be some times real, but often it is a mere deception; and the motion of the heart and of the lungs do not go on in the usual manner. Sometimes he complains of heat in the rest of the body; but generally, to a person feeling the limbs, there is an evident sense of coldness, and often the patient complains

of coldness in the extremities. If he makes any attempt to walk up hill, he is quickly obliged to stop, soon becomes extremely oppressed, and feeling the pulse, it is irregular at that time. But the distinguishing pathognomonick sign is, that the heart strikes the side lower than the common place. It has been observed that the point of the ventricle strikes the thorax as low as the 9th rib; and if, upon laying the patient on the left side, we find the stroke under the 7th rib, we may be certain that there is a considerable dilatation. This depends upon the constriction of the orifice, and we may in some measure form an opinion of the degree of that. Some patients live much longer under the complaint than others, and in a manner we cannot account for. Upon applying the hand to the side, we feel a great many more strokes given to it than we find given to the finger applied to the pulse. Upon making the experiment, 120, or 130, may be reckoned, when it is impossible to reckon above 86, or 90 strokes of the pulse, many of the strokes being so weak that they were soon lost.

DCLXXXIV.

Ossification of the Semilunar Valves.

The most common ossification about the heart is that of the semilunar valves, depending on the deposition of a bony or earthy matter from the small nourishing arteries. But without ossifica-

tion, they are also found considerably thickened, and white and opaque in colour, and the neighbouring arteries partake likewise in a certain degree in the same state. This thickening is sometimes attended with a rupture, though it is a rare occurrence.

DCLXXXV.

Offification of the Auricular and Ventricular Valves.

These valves are liable to assume the same morbid state as the former; but by no means so frequently as the former, from their belonging more to parts of a venous nature. As well as suffering ossification, they are also subject to a thickening and opacity, and which is extended to the chordæ tendinæ, and lining of the ventricle. Even inflammation of those parts occurs at times.

DCLXXXVI.

But an enlargement of the heart is apt to occur without any particular organic cause. In this case the muscular cavities are often not thick in proportion to the increase of size. The heart is generally found filled with blood, partly formed into a loose concretion.

Symptoms.

The marks of this morbid state are frequent palpitations, so strong as to be perceived by the eye without the clothes. In general, the pulse is feeble and irregular. At times there prevails dyspnæa, with a purpleish hue of the cheeks and

lips, which varies in deepness according to the degree of dyspnæa. Rheumatism has been stated as a cause of this affection.

DCI.XXXVII.

Aneurism.

This organ has at times become aneurismal, part of it dilating into a pouch filled with coagulated blood, and lined with a thick white opaque membrane. This depends on a weakening of the muscular fibres in the part which yields to the impulse of the circulation. But the most frequent seat of this disease is at the arch of the aorta, which becomes much enlarged, forming either a uniform tumor, or smaller swellings arise out of the large one. This tumor is filled more or less with coagulated blood, disposed in concentric laminæ, and the coats of the artery preserve a proportional thickness to its enlargement, a new deposition gradually taking place by the action of their small vessels. The coats of the artery are accordingly here more divisible into layers, occasionally displaying in them spots of bony matter, often of a yellowish colour. In the neighbourhood of the disease, the arterial coats differ in their thinness and thickness at different places, and always bear more or less marks of disease.

The disease sometimes terminates by a rupture and effusion into the pericardium at once, but more frequently it is slow in its progress, and the

swelling gradually increasing, it presses at last against the sternum and ribs, a portion of which becomes absorbed, and the tumor appears externally. In this manner it attains at last the size of a child's head at birth, and the skin losing entirely its vitality and cracking, part of the coagulated blood is forced out, and the patient is either instantaneously cut off; or if it is slower, sinks gradually under the discharge.

The arch of the aorta, from its curvature, is more particularly the seat of aneurism, as the blood presses against it with full impetus, and it occurs often in men, but rarely in women, whose arterial system seems less subject to disease.

Symptoms.

In its early stage, this affection is marked by a strong pulsation felt in the chest, visible to the eye on the thorax being exposed. The pulse at the wrist is sometimes irregular, dyspnæa on exercise always attends, and that in proportion to the progress of the disease. But the most certain symptom is the appearance of an external tumor, with strong pulsation.

DCLXXXVIII.

Rupture.

Rupture of the heart sometimes occurs, and chiefly to men in advanced life. The blood escaping into the pericardium, death immediately ensues. It is the consequence of exertion at the

time, and some part of the organ being thin. Without rupture blood has been accumulated in the pericardium to a considerable quantity, and this must have been supplied either by the coronary or pericardial vessels.

Symptoms.

The symptoms of blood effused gradually into the pericardium are great faintness, dyspnæa, considerable anxiety and oppression, with dull pain, and weight behind the sternum. These symptoms are succeeded by cold clammy sweats.

DCLXXXIX.

Hydatids, &c.

Hydatids have been found, though a rare occurrence, adhering to the heart, and a part of the organ has been also converted into bone, and earthy depositions form in its muscular fibres, which are rare phenomena.

Symptoms.

In the first case, the symptoms will be the same with those of water collected in the pericardium, with particular tendency to fainting.

In the latter case, palpitation of the heart and dyspnæa have been the leading marks.

DCXC.

Diseased Arteries.

After the heart, some observations occur on the affections of the arteries, particularly aneurism, as not being confined entirely to the arch of the

aorta. From the structure of the arteries, besides accidents arising from wounds, we may conceive that they may be dilated or ruptured; or we conceive a dilatation taking place in a certain degree, and a rupture afterwards, some sudden violence producing a laceration of their coats. So aneurism is divided into two kinds, where the whole, or where only a few of the coats are ruptured or cut, and this rupture may be occasioned by an effort of the artery: so, by blowing in air, the first coat has been burst, and the rest yielding, a sack was formed, and it is seldom that all their coats are found dilated; for it generally happens in one part only, which comes to be so much diseased, that it is impossible to say what particular part is affected; for as to the marks that have been proposed, that the branches of the arch of the aorta will be found at a great distance, that would have more readily happened if the other coats had been corroded: so we may suppose all the coats dilated, or we may suppose that all the coats shall suddenly give way, that by a sudden effort of the ventricle the aorta may burst, even though it is not previously diseased; or, after the dilatation is advanced a certain way, the coats may be consumed by pressing against some hard and resisting substance, in consequence of which a rupture will readily take place. Thus, in some cases, the sternum has been split from the top, and has come

to be opened the whole way down, so that the aneurismal sac has been situated just where the arch of the aorta passes over the left branch of the trachea.

DCXCI.

The causes of aneurisms are various, and a number of circumstances may be supposed to occur. Nay, we shall find aneurisms where it is impossible to give any explanation of the cause: no cause can be assigned for the various dilatations which occur in different parts of the body. The arteries are subject to a certain rupture, and we may suppose that we understand how this may be occasioned, by the violent action of the heart; but how are we to explain a circumstance of the heart itself, that it is found to give way even in its thickest places?

DCXCII.

Of this we are apt to overlook the real cause, to conceive somewhat impelling the blood with force, so as to occasion the rupture; and therefore that it is done from pressure. Ruptures have happened in that way. Thus, the right auricle is filled with blood, and if the patient makes a violent effort in expiration, and bends the body; perhaps, at the same time, the expiratory organs and other muscles will press with such force upon the auricle, that the parts of it may give way; but, in other instances, we must suppose an exer-

tion of its own fibres to produce the laceration; for not merely the tendons of the muscles may be lacerated by a sudden effort, but the muscles themselves. Thus, the calf of the leg is known to be lacerated from a person's making too great an exertion with the muscle; and we must account for the laceration of the heart in the same manner. Nay, we cannot account for the dilatation of the heart in every part, from an affection in the beginning of the aorta. It is not the force of the blood running in from the veins that occasions the dilatation; the only cause is the action of the heart itself, which, by endeavouring to make itself smaller, is increased. This may seem paradoxical; but the more it is considered, it will appear more evident, for the heart makes a violent effort to throw out the blood, which is repeated in proportion to the resistance that it meets with; and hence the quickness of the pulse in feverish disorders. By the effort, the fibres are distracted; there is an endeavour of these to shorten; but, when the effort ceases, they in reality become longer than before. Thus the particles of the fibres are drawn asunder, and the void is gradually filled up, till the heart is by degrees dilated, and we find little loss of substance, but the thickness seems to increase in proportion to the dilatation.

DCXCIII.

There is some danger of mistaking tumours of the aorta for tumours of another kind, or of mistaking those for tumours of the aorta; for sometimes the artery does not enlarge equally, but a part of the blood stagnates out of the course of the circulation, coagulates, and gives such a degree of firmness, that we can easily distinguish the pulsation; and, on the other hand, sometimes tumours of another nature, whether containing a fluid, or composed of solid matter, happen to form near an artery, and have the stroke of the artery communicated to them.

DCXCIV.

DISEASES OF THE PLEURA.

Inflammation.

The investing membrane of the thorax, or pleura, is the frequent seat of inflammation, especially on attaining the adult state, and it is more so than that of any membrane lining a cavity which has no external opening. Hence, marks of inflammation are conspicuous here on almost opening every subject. It is marked by its thickened pulpy state, its vascular appearance, and its surface covered by coagulable lymph of various thickness, sometimes smooth, sometimes reticulated like lace-work, and attended with an effusion of serum into the thorax. This coagulable lymph is the medium of adhesion, being formed between

the lungs and thorax; and it may be traced in its progress from the state of lymph till vascular, and formed into cellular membrane. The inflammation of the pleura of the lungs is frequently extended to the organ.

Symptoms.

The symptoms of pleurisy are general fever, with acute pain in the lateral part of the chest, increased by inspiration, dyspnœa, cough, and difficult recumbence on the affected side.

DCXCV.

Adhesion.

One of the most frequent morbid appearances on opening the thorax, is adhesion between the containing pleura and its layer on the lungs, without any existing marks of inflammation. Being mostly partial, their most common seat is the upper posterior part of the chest, though they at times extend over the whole cavity. The connection they form is of two kinds, either by a close adhesion of firm thick membrane, or of a loose complex layer of cellular matter. Such adhesions must always be the effect of previous inflammation.

Symptoms.

It is only when the adhesions are firm and short, so as to confine the expansion of the lungs, that this state is marked by external symptoms. These are difficult respiration, cough, and an attending fever.

DCXCVI.

Empyema.

The accumulation of pus in the cavity of the chest, forms empyema; and it arises either from the vessels of the pleura under inflammation forming pus, or from an abscess in the lungs bursting into the thoracic cavity. Pus may be formed in the pleura without ulceration, in consequence of the excretion of coagulable lymph on the surface; and it may either fill the whole cavity; or, in consequence of adhesions, be circumscribed to a certain part.

Pus also from an abscess in the lungs, is almost always circumscribed in its extent by the previous adhesions formed; though not in general can an external fullness be perceived on the side where the accumulation is, and even a sensible swelling perceptible to the feel. Ulceration has, at times, likewise occurred in some of the intercostal spaces, and matter from it is seen discharged outwardly.

Symptoms.

The symptoms of empyema are previous inflammation of the pleura or lungs, on the remission of which rigors take place, with an abatement of pain. Cough, and dyspnœa still continue, and an easier recumbence is allowed on the diseased side. Sometimes external enlargement gives farther evidence of the morbid state

DCXCVII.

Hydro-thorax.

A watery fluid in one or both thoracic cavities constitutes hydro-thorax. It is generally attended with the same state of the other cavities, especially of the pericardium and lower extremities. The fluid contained here is of a brown or yellowish colour, with an occasional reddish tinge. In its general properties it resembles the serum, varying occasionally both in its nature and extent, from some ounces to an equal number of quarts. From the latter quantity, the accumulation appears externally on one side by the apparent fullness. The effect of it is a greater or less compression of the lungs, so that one side of them is found at times larger than the closed fist. Water also often accompanies adhesion, marking the presence of former inflammation.

Symptoms.

The marks of hydro-thorax, in its advanced stage, are pretty clear. Difficult breathing, and no rest, without elevation of the superior parts of the body, are leading ones. Suddenly interrupted sleep, with alarming dreams, retention of urine, and œdema of the extremities also attend. The pulse commonly, though not always, is irregular. Sallowiness of colour, and a purple hue of the lips and cheeks, are conspicuous, as marking the compression of the organ, and imperfect oxidation of its circulation.

DCXCVIII.

Deficient Secretion.

The natural internal moisture on the surface of the pleura is sometimes found wanting, or in such quantity, that it appears almost dry.

Symptoms.

This state is marked by no peculiar symptoms.

DCXCIX.

Ossification.

An occasional point, or thin plate of bone, more or less extensive, is found in the pleura, from its vessels taking on the particular disposition favourable to the formation of this matter. This appearance is common to all membranes, but more to the pleura than to any other; and unless forming sharp processes, or very extensive, this change cannot be attended with much inconvenience.

Symptoms.

Where this affection is extensive, the symptom of difficult breathing will arise from want of full expansion of the lungs, or free movement of the ribs.

DCC.

DISEASES OF THE LUNGS.

Inflammation.

Inflammation of the lungs and pleura are conjoined. By inflammation the spongy structure of this organ is more reddened, partly of a florid,

and partly of a dark red hue. An extravasation of coagulable lymph, and occasionally of blood, takes place into the substance of the lungs. With this morbid change their specific gravity is increased, they sink in water, and feel solid to the pressure of the finger, in proportion to the degree of inflammation. The pleura displays also an increased vascular appearance, with a layer of coagulable lymph covering its surface. The inflammation of the lungs differs from their extravasation after death, by the want of increased vascularity, or marks of inflammation of the pleura, and by the colour of the lungs being of an uniform dark shade, without any floridness.

Symptoms.

The symptoms of inflamed lungs are much the same with those of pleurisy, only the pain is less acute, and the pulse not so hard. There is here difficult respiration, accumulation in the veins of the neck, face swelled, and a purpleish hue of the lips and cheeks. On suppuration taking place, rigors occur, with diminution of pain, and expectoration of pus.

DCCI.

Abscess.

Abscess is a common appearance in the lungs, consisting either of small cavities containing pus, or at other times of large ones, destroying almost their whole structure. These cavities either communi-

cate alone with branches of the trachea, or opening into the thoracic cavity, pour out their contents so as to form empyema. Deep seated abscesses occasion the pleura to be little affected, but in the superficial ones it assumes inflammation. The texture of the lungs is rendered more solid in the neighbourhood of abscesses, but in scrofulous cases this does not take place, as commonly appears in small abscesses. In the vicinity of an abscess the pulmonary vessels are much contracted, and their extremities, before re-uniting, are almost entirely closed or filled with coagulated blood, as an effort of nature to prevent hemorrhage.

Symptoms.

The symptoms are here the same as described in the termination of the pulmonary inflammation.

DCCII.

Tubercles.

Tubercles are the most frequent morbid appearance in the lungs, and consist of round firm white bodies, interspersed through its substance. Their seat is the cellular substance that connects the air vessels. Their size at first is not larger than a pin head accumulated in clusters, which pass into one larger one, and the smallest tubercle is not below the size of a garden pea, though admitting a great variety. Their adhesion is close to the lungs, without any peculiar covering or increased vascularity. When cut into, their struc-

ture displays a white, smooth, firm substance, containing in a part of it a thick curdy pus; and in its farther progress, by the increase of fluid, a white capsule comes only to be left, forming a covering to this fluid.

The connection of several tubercles always tends to the formation of pus. The appearance and consistence of the pus is regulated by its quantity, being thick when small, but thin when in large proportion. On dissection, several tubercles are often found advanced to the state of suppuration, while the interstices of the pulmonary substance near them displays a hard firm texture, and an obliteration of cells. Where small abscesses occur, the disease is evidently scrofulous, and exhibits a thick pus. The conversion of tubercles into abscesses forms phthisis pulmonalis, and tubercles are formed in every period of life, though most frequently before the completion of growth. They are also frequently produced in the advance of life.

Different from tubercles, on dissection of the lungs, part of their substance is found changed into a soft whitish matter, of a semifluid consistence, resembling an imperfect suppuration; and, while the tubercle is circumscribed, this state is more diffused through the cellular substance.

Another variety of tubercle is also occasionally conspicuous, consisting of a light brown, smooth

substance on the surface of the lungs, equalling a gooseberry in size, without any capsule, or appearance of matter formed; and sometimes they are even much smaller, and extensively dispersed. The peculiar morbid process forming them is uncertain.

Symptoms.

Incipient tubercles are marked by a slight cough, occasional dyspnœa, and a somewhat quickened pulse, symptoms frequently overlooked for a long time. In the progress to suppuration, there appears an expectoration of thick pus, occasionally mixed with blood, gradually producing emaciation, debility, and hectic fever, with its concomitant symptoms.

DCCIII.

Water.

From an accumulation of the aqueous moisture naturally intended to facilitate the easy motion of one part of the lungs upon another, disease arises, forming what may be properly termed anasarca of the lungs. In proportion to this accumulation of water in the the cellular membrane, a compression of the air cells will take place, and an imperfect oxidation of the blood from the deficient quantity of air will arise as a consequence.

Symptoms.

Where water exists in this situation, the usual symptoms of dyspnœa and cough will attend; but

the same accumulation will also shew itself in other parts of the body.

DCCIV.

AIR.

External Accumulation.

Rupture of the membrane of the lungs may take place occasionally, and the air may be effused into the thorax, though this happens but seldom, because the outer membrane is not put to the full stretch when the lungs are distended, and the containing parts give it a support. When it happens, the diaphragm is found convex, and, on opening the thorax, a great blast of air will be found to issue out. The lungs of that side appear compressed and squeezed, at the top of the thorax, to no bigger a size than that of one's fist, and they are almost as hard as any other of the solid viscera, without the probability of inflating them, by blowing in air from the trachea.

Symptoms.

The symptoms here are, sharp pain of the side succeeding a violent fit of coughing, followed by difficulty of breathing and swelling of the side, often diffused over the whole body, where the pleura is joined in the accident, and the rupture extends through it.

DCCV.

Internal Accumulation.

Distension of the lungs with air is a common

appearance on opening the thorax, no collapse of them taking place, and their surface being covered with numerous white vesicles. In this case the branches of the trachea are also found gorged with mucus.

DCCVI.

Enlargement of the Air Cells.

An enlargement of the cells of the lungs is an occasional appearance, from the difficult egress of their contents, and the rupture, perhaps, of two or three into one larger cavity.

Symptoms.

The marks of enlarged air cells are long difficulty of breathing, but no farther discrimination has been made from external symptoms of this peculiar morbid state.

DCCVII.

Preternatural Formation of the Air Cells.

Such cells are seen at times attached to the edge of the lungs, without communication with the structure of the organ; and they are certainly a morbid growth, receiving their air from the vessels that ramify upon them.

Symptoms.

No peculiar symptoms characterize this morbid appearance.

DCCVIII.

Hepatic Appearance of the Liver and Lungs.

The lungs are often seen converted into a solid

substance, of the same general appearance and solidity as the liver. It is the effect of sudden and large extravasation of coagulable lymph into their substance. In consequence of this, from the degree of compression, a total interruption of their office must ensue.

Symptoms.

This state is marked by violent inflammation, and the sudden fatality of the attack.

DCCIX.

Earthy Concretions.

The appearance of earth in the lungs, though rare, has at times been met with. The masses formed by it are generally very small. Part of the lungs has even been converted into this substance.

Symptoms.

Along with difficult respiration and cough some of this earthy matter is brought up, which shews the peculiar morbid state.

DCCX.

Hydatids.

Hydatids of the lungs are an occasional morbid appearance, similar to hydatids in other situations.

Symptoms.

The attendants of this state are dyspnæa, and frequent cough. Being forced up by violent coughing, their appearance characterizes the disease.

DCCXI.

DISEASED APPEARANCES OF THE TRACHEA AND
ITS APPENDAGES.*Thyroid Gland.*

Inflammation of the thyroid gland is a rare occurrence. It does, however, at times take place, and an increased vascularity of its substance, and extravasation of coagulable lymph both increasing its usual size and firmness, is a natural consequence of this affection.

Symptoms.

Inflammation here may be known by the increase of size, by a sense of pain in the part, felt more severe on pressure or swallowing, and it is chiefly distinguished from other affections here by the rapidity of its progress.

DCCXII.

Bronchocele.

The most frequent affection of this gland is its chronic swelling, named bronchocele. It appears a hereditary distemper, more common to women than men, and confined chiefly to certain countries or districts. This swelling often enlarges to a prodigious size, with an irregular growth, projecting anteriorly upon the neck. This is particularly remarkable in Savoy. A section of the gland in this morbid state shews a number of cells formed, containing a viscid transparent fluid. The size of these cells is various in different cases, but

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most of them are under that of a pea. This viscid fluid becomes changed by stagnation into a jelly. Thus a morbid and increased secretion of the gland is the cause of the disease.

Symptoms.

Bronchocele is particularly distinguished by its slow growth, by the particular size to which it is capable of arising, by its want of pain, by its occurrence in early life, by the firm sensation it yields to the touch, and by its having no influence on the general health.

DCCXIII.

Schirrus of the Thyroid Gland.

The thyroid gland is the seat, at times, of schirrus, by which it enlarges in size to some extent, being also hard to the feel. On cutting into it, this consists of a solid whitish brown substance, with little appearance of cellular structure. It is often produced by ulceration of the œsophagus, particularly at its upper end, extending to the gland, though it occurs also without this affection extending to it.

Symptoms.

Schirrus here is distinguished by its degree of hardness, attended with occasional darting pain by its lesser size than in bronchocele, and by the advanced period of life at which its attack is made.

DCCXIV.

Osification of the Thyroid Gland.

The conversion of this gland into osseous matter is generally partial. It takes place only in very old people, and is a rare disease. No particular consequences therefore follow this morbid state, unless it should prove so large as to communicate irritation to the larynx or trachea.

Symptoms.

This state of the gland can only be known by accurate examination. If external, it will be easily ascertained. If more internal, its nature must remain somewhat doubtful.

DCCXV.

Osification of the Laryngeal Cartilages.

This is an affection met with from the middle to an advanced period of life. It is connected with the former affection, and the bony disposition of the gland extends in its progress to the larynx. Assuming the nature of bone, the cartilages are liable to its changes, suffering exfoliation, and being thrown out by an effort of coughing; but this process of exfoliation is extremely rare, though it has been known to occur.

Symptoms.

The chief marks of this state are denoted by the change of the voice, which becomes either rough and hoarse, or changed into a whisper from the want of pliancy in the organ. The ligaments

remain in their natural state; but by this change the power of swallowing becomes lost, and death ensues from this cause.

DCCXVI.

Ulceration of the Larynx.

The inflammation of the larynx is apt to terminate in suppuration, and the seat of the latter is the sacculi laryngis. Ulceration becomes a consequence, which shews, by the thickening of the surrounding parts, a scrofulous disposition.

Symptoms.

The symptoms of this affection are fixed pain in the situation of the larynx, dyspnœa, change of voice, and symptomatic fever.

DCCXVII.

Inflammation of the Trachea.

This state is marked by its increased vascularity, and its changing its natural white pulpy appearance. The consequence of this is an increased secretion, as its cavity is filled with mucous fluid, occasionally with pus, both fluids containing globules of air. This is its situation in cattarrh; and in the advanced stages of consumption, along with hoarseness, from a similar state of the larynx, and soreness along the trachea.

Symptoms.

The general symptoms of cattarrh mark this state; and when the soreness extends down the middle of the chest, the inner tracheal membrane

is inflamed. The subsiding of the inflammation does not for some time remove the increased secretion. The inflammation in consumptive cases is chronic, and long continued.

DCCXVIII.

Morbid Lining of the Trachea.

In some few diseases there is an appearance of a yellowish and pulpy matter, which is supposed to be owing to an increased quantity of mucus, and that dried upon the trachea, and which appears in the form of a membrane. But it is doubtful whether it is owing to mucus, or we are rather to consider it as a crust formed by an inflammatory exudation, just as in the peritonæum or pleura there is discharged a liquor which gradually inspissates and forms a crust of the lymphatic part of the blood; and upon exposing the blood in the trachea to ardent spirits, it gets a considerable degree of hardness, while we do not observe so great a change produced upon mucus by such an addition.

In some of these diseases, a few authors have considered the crust as the cause of the disease, though it is rather to be viewed as the effect; and though we could remove the crust by a wish, we could not cure the patient, nor does the danger depend upon the incrustation. In children dying of the croup, the passage for the air is not intercepted by the membrane. These membranes may

separate from the trachea, and be a cause of much uneasiness; and it may happen that in collecting they may stick in the larynx and suffocate the patient; but they are no more the cause of the disease than a furred tongue in a fever is to be considered as the cause of the fever.

Symptoms.

The symptoms of croup with which this appearance is attended, are difficult respiration, stridulous wheezing, cough, hoarse voice, general fever, with the occasional expectoration of pus, and a whitish membrane.

DCCXIX.

Tracheal Polypus.

A layer of coagulable lymph is found often to line the internal surface of the trachea and its branches, without any other morbid appearance affecting the membrane. This affection shews no marks of inflammation, and is of long continuance. At other times, a more solid substance fills the same situation. In both cases the vessels seem to display a peculiar action in separating the coagulable lymph, which is coughed up in a tubular form, and has been termed a polypus.

Symptoms.

The marks of this affection are difficult breathing, a dry cough, an increased pulse, without any attending signs of inflammation, and, at times, pieces of the polypus coughed up.

DCCXX.

Tracheal Schirrus.

By this affection the passage of the trachea is narrowed, its substance thickened, and its inner membrane formed into hard tubercles. Along with this, swelling of the neighbouring lymphatic glands is conspicuous.

Symptoms.

The marks of this state cannot be certainly determined, for the same symptoms will attend as mark some of the preceding affections.

DCCXXI.

Offification of the Tracheal Rings.

This state will be little attended to when slight; but, when so considerable as to affect the functions of the part by lessening the flexibility of the membrane, its cavity will not contract in the necessary degree. The air and mucus form the pulmonary cavity.

Symptoms.

The accumulation of mucus, or rather its difficult discharge, will be the only leading mark of this morbid affection.

DCCXXII.

Ulcer of the Trachea.

The trachea, like other passages, is liable to ulceration, though this most frequently spreads from the œsophagus to it, and the disease falls to be considered under the œsophagus.

DCCXXIII.

Aphthous Œsophagus.

A layer of coagulable lymph is found to extend from the mouth over the Œsophagus, and even to occupy the alimentary canal. This appearance forms what is named aphthæ. An increased vascularity attends it, though less conspicuous in the Œsophagus than in the other parts, and it generally disappears after death.

Symptoms.

The symptoms of this affection are known by the appearance of the mouth.

DCCXXIV.

Spasm of the Œsophagus.

Irregular contraction of its muscular fibres at a particular part, is common in hysterical patients, which continues after death, and gives a hardness of feel. This may accordingly, often repeated, lay the foundation of permanent disease, and excite inflammation so as to terminate in some of its secondary consequences.

Symptoms.

This state is marked by occasional difficulty of swallowing, sudden in its attack, and sudden in its remission; neither is there any change of the general health.

DCCXXV.

Partial Stricture of the Œsophagus.

A narrowness of this canal at a particular place,

is sometimes formed by a puckering of the inner membrane to such a degree as hardly to allow a pea to pass; and no other attending morbid change seems connected with it, to account for the altered organization. This affection is slow in its progress for a period of years.

Symptoms.

The constant difficulty of swallowing, and the long period of its duration, are the only leading symptoms of this complaint.

DCCXXVI.

Ulcerated Stricture of the Œsophagus.

Ulceration of the Œsophagus is the most common morbid change conspicuous in this part, and it is generally preceded by its scirrhus state, consequently, by a thickening of the substance to a greater or less extent. This thickening is either of a hard uniform substance, or of a membranous gristly nature. By this circumstance a contraction of the passage is induced, and often an almost total obliteration takes place. The most frequent points of ulceration are the upper and lower parts of the Œsophagus, from the arrangement of their muscular fibres rendering them more liable to be affected by irritation. Ulcerations here, however, are generally induced by no apparent cause; and, when affecting the upper part, they extend to the thyroid gland, which assumes the scirrhus, and afterwards the ulcerated state.

Symptoms.

This disease is marked by its gradual progress. The difficulty of swallowing, at first slight, gradually increases. In the advancement of the disease the food becomes rejected, and there is seen along with it the occasional appearance of pus. The pulse is increased, emaciation takes place to an extreme degree; the neighbouring parts, from irritation, shew an increased discharge; hence cough and hawking arises. Little nourishment is received, and yet the sense of hunger is not great.

DCCXXVII.

Cartilaginous Œsophagus.

The conversion of the œsophagus into cartilage is only very partial, and may be considered as a greater degree of schirrous or gristly hardness in a particular point.

Symptoms.

The same symptoms distinguish it as schirrus before ulceration.

DCCXXVIII.

Fungous Pharynx.

Fungosity of the pharynx, to a certain extent, though rare, has been met with. On dissection it displays a fibrous structure, with its surface more or less ulcerated. A scrofulous tumor has been observed in the same situation.

Symptoms.

The symptoms are much the same as those of the œsophagus.

DCCXXIX.

Dilated Pharynx.

A dilatation of the lower end of the pharynx, forming a pouch, occasionally appears where a nucleus first gives a predisposition to it, by forming a small bed. Thus it has arisen from the stoppage of a cherry-stone at this part, which, though removed in a few days, left a small cavity. By this occasion was given for the constant resting of the food in future there; and the subsequent change was of course a gradual consequence.

Symptoms.

The only marks of this state are the difficulty of food passing into the œsophagus, and at last becoming so difficult as to destroy the patient.

DCCXXX.

Vena Azygos enlarged.

This vein has been occasionally known to be varicose, and also a rupture of it to take place.

Symptoms.

No external marks, however, can give evidence of this state.

DCCXXXI.

Enlarged Thoracic Duct.

The chief morbid change on this part is its varicose state, and without any other appearance

of disease. This can be known by no external symptoms.

DCCXXXII.

Obstructed Thoracic Duct.

An obstruction of the thoracic duct has been seen by the deposition of an earthy matter in it. It is only partial, and by its branches the nourishment is still conveyed to the system. Rupture of it, though a rare occurrence, has been also known.

DCCXXXIII.

Ascitic Abdomen.

Dropfy of the abdominal cavity is more frequent than elsewhere, and appears at every age, and in both sexes. Middle and advanced life are its most common times of attack.

By the distention of the abdominal cavity, the superficial veins are seen turgid with blood, the skin of the navel is protruded and yields to pressure, though this is not a constant symptom. On opening the cavity of the abdomen, the aqueous fluid discovered is of a brownish colour, though varying according to circumstances. An affection of the liver gives it a yellowish or greenish hue. At times, also, it is of a chocolate or coffee colour. Where no diseased viscera attend, the morbid accumulation resembles the serum both in colour and properties. The accumulation of the abdomen often produces contraction of the intestinal canal. The liver, or some of the other viscera in a

scirrhus state, is commonly connected with acites, though not always. Accumulation of water, also, in the other cavities, is frequently conspicuous, particularly in the chest and lower extremities.

Symptoms.

The symptoms of ascites are, a distended fluctuation on applying the hand to the belly and striking it with the other, paucity of urine and high coloured thirst, and sense of heat, with some frequency of pulse. In the advanced stage respiration is impeded.

DCCXXXIV.

Inflamed Peritonæum.

The peritonæum is less subject to inflammation than the pleura, and it occurs at times in both sexes, though women after parturition are peculiarly predisposed to it. The inflamed peritonæum appears thick, pulpy, and less transparent, with an increased vascularity. The inflammation never extends to the muscles, but it affects the intestinal canal, and penetrates through the coats of the bowels.

The extent of peritonæal inflammation varies, being at one time slight and partial, at another great, and general over its surface. When chiefly affecting the intestinal division, broad bands of inflammation are formed, which observe the course of the intestines, and are formed by the contact of the different intestinal portions; and the intestines,

when examined, are no way thickened in their texture by the progress of the inflammation; but, where the inflammation is evident, the intestines acquire a thickness and massy feel, in consequence of increased action of vessels and extravasation. The peritonæal appendages, or the mesentery and mesocolon, are much thickened, as well as the omentum; and this may be ascribed to the extravasation of coagulable lymph that takes place to this cellular substance. Besides these changes, different portions of the viscera are often glued together by a yellowish pulpy matter, varying in its degree of thickness in different cases by the coagulable lymph of the blood; and with this there is effused a brownish fluid in the cavity of the abdomen, of a serous nature, mixed with threads of coagulable lymph, and occasionally pus, by which it is rendered turbid. These extravasations often extend in proportion to the apparent degree of inflammation. Pus and air are also part of the collection met with here, the latter being most common in slight cases.

Symptoms.

The marks of peritoneal inflammation, are pain of the abdomen, with some swelling, and much soreness to the touch. The pulse is increased and hard, with other general marks of fever, and most commonly costiveness. In slight cases, the symptoms are often hardly perceptible, and hence the

disease is found highly insidious, and its true nature only discovered by dissection.

DCCXXXV.

Abdominal Adhesions.

The effect of peritonæal inflammation, where not fatal, and much coagulable lymph is thrown out, is to form a fine transparent membrane, which is the medium of adhesion. This process soon takes place, and the membrane possesses the same appearance as cellular membrane in other parts, and possesses a sufficient share of vascularity. Hence it can be injected, and shows also a redness when inflamed. This membrane also elongates with the action of the viscera; and though joining them together more or less, it is attended on that account with less inconvenience than might be supposed.

Symptoms.

No peculiar symptoms attend the presence of adhesion.

DCCXXXVI.

Scrofulous Accumulation on the Peritonæum.

A white, soft, granulated matter, appears at times behind the peritonæum, and seems very universally extended, formed in one large thick mass, or in small ones. The omentum seems entirely changed into this substance. The morbid change seems to resemble that of the absorbent glands in other situations.

Symptoms.

This appearance is marked by no peculiar symptoms.

DCCXXXVII.

Cancer of the Peritonæum.

Small cancerous tumors are found at times adhering to the peritonæum, hard and white in their structure, and occupying that part in the region of the stomach. This cannot be traced by any certain marks. Scrofulous tumors have been also observed here.

DCCXXXVIII.

Abdominal Hydatids.

Abdominal hydatids are found occupying the whole of the cavity. They are connected with some of the viscera, to which they owe their formation; and they particularly proceed from the state of the liver and spleen.

Symptoms.

This disease is to be distinguished from ascites by an indistinct fluctuation, on examining as in ascites; or by none at all, by the commencement of swelling in a fixed point, from which it becomes diffused. From ovarian dropsy it is distinguished by the latter commencing in the side, and gradually extending from that over the abdomen, while, in hydatids, the swelling is from the upper part of the belly, or region of the liver, spreading downwards. This disease, however, may

begin at any part of the belly, which renders all its distinctions doubtful.

DCCXXXIX.

Abdominal Accumulation of Air.

Air is occasionally collected in the abdomen, without any in the intestines. The collection, however, is most common in the intestines, by which they become distended, and their coats thinned; and on examining, it is impossible to say whether this accumulation takes place in the abdomen or the bowels.

DCCXL.

MORBID CHANGES OF THE STOMACH.

Inflammation.

General inflammation of the stomach is always the effect of poison, and therefore not so frequent; but partial inflammation is a common occurrence. In the latter case, the inflammation is seldom violent. The external surface shews, at this part, an increased vascularity; and on opening the organ, its substance is here thickened. The inner membrane acquires considerable redness, with some degree of bloody extravasation. Common inflammation seldom terminates in pus or gangrene. From arsenical poison, the most violent inflammation of this organ takes place. Much redness, and thickening of its substance, is produced along with bloody extravasation. Part of the inner membrane is also occasionally destroyed, and a thin

layer of coagulable lymph at times thrown out on the surface of the organ. When the substance has passed farther than the stomach, ulceration of the intestines has occurred. It has been particularly observed in the rectum.

Symptoms.

Inflammation of the stomach is marked by pain in the epigastric region, increased on swallowing, by vomiting, and hiccup, with a frequent small hard pulse, by much heat and thirst, and by an uncommon sense of debility. In cases of arsenic, these symptoms rise to a still more violent degree.

DCCXLI.

Hydrophobic Affection of the Stomach.

Dissections of hydrophobic patients shew the stomach inflamed at the cardia and great end, and this inflammation seems to descend from the pharynx and œsophagus. The inflammation is generally of the erisipelatous kind.

Symptoms.

Hydrophobia is peculiarly marked by the morbid aversion at fluids, by the difficulty of swallowing, and by the strong derangement of the mind attending this state.

DCCXLII.

Ulcers of the Stomach.

Ulcers of the stomach occasionally appear on dissection, and they either resemble those on other parts of the body, or they appear as if a part

had been cut out with a knife. These ulcers at times only corrode part of the coats, at other times they make a hole in the organ. In the vicinity of this ulcer the coats of the stomach display sometimes a thinness, at other times they are thickened, and, on other occasions, they preserve the natural state.

Symptoms.

The symptoms of this affection are, pain of the stomach and rejection of food, while no plan of treatment gives relief. The disease is generally slow in its progress.

DCCXLIII.

Schirrus and Cancer of the Stomach.

This disease is displayed chiefly in men in advanced life. Although without predisposition, intemperance cannot be considered as its cause, it then has considerable influence. Schirrus of this organ is most commonly partial, and the limits between the diseased and sound part of the organ are generally very distinctly marked. In partial schirrus, the pylorus is the part most affected, from the more glandular nature of its structure. By this affection the thickness and hardness of that part of the organ is increased; and when cut into, the original structure, though still distinct, is altered in appearance by the peritoneal covering acquiring a gristly hardness, and the thickened muscular part being intersected with strong mem-

branous septa; while the inner coat, besides being thick and hard, is towards the gastric cavity somewhat tuberculated. The ulceration of this changed and thickened texture on the surface constitutes cancer, and fungus frequently proceeds from processes of the inner membrane. The organ is, indeed, often entirely changed into a mass of a whitish or brown colour, or converted into a substance somewhat cartilaginous. In this morbid state the neighbouring absorbent glands are enlarged.

Symptoms.

Cancer of the stomach is attended with pain of the organ, with the rejection of what is taken, and frequently with the vomiting of a coffee-coloured fluid. Emaciation, and fallow countenance, are attending symptoms, with frequency of pulse, and the formation of hectic. No peculiar symptoms mark the disease where unaccompanied with ulceration.

DCCXLIV.

Small Tumor of the Stomach.

An occasional appearance of schirrosity, different from the former affection, is met with in a small tumor the size of a walnut, while the rest of the organ is entirely in a healthy state. What effects this tumor may have under the influence of irritation in disordering the functions of the organ, have not been ascertained. Mechanical means may produce a preternatural cavity in the stomach,

or a pouch. Where that occurs, the coats of it are thinner.

DCCXLV.

Stricture of the Pylorus.

Stricture of the pylorus oftener occurs than at the cardia, as the fibres possess stronger powers of contraction; and it has been found so great as hardly to admit a goose quill to pass from the stomach into the duodenum.

Symptoms.

The chief symptoms of this state will be the rejection of every thing taken, and fixed pain in that part; while the body, from being deprived of its nourishment, soon declines.

DCCXLVI.

Altered Capacity of the Stomach.

The stomach is sometimes so contracted as not to exceed the size of a small intestine, and on other occasions its dimensions are equally enlarged. These appearances are not the effect of disease, but depend on an irregular contraction or relaxation of the muscular fibres at the period of dissolution. The state of dilatation is most frequent.

DCCXLVII.

Distension of the Stomach.

Though generally flaccid and empty at death, this organ is also found occasionally distended with air, and this air is commonly extricated from the contents of the stomach, or from its circulation.

Symptoms.

The symptoms of this state are external swelling of the epigastric region, with a sense of distention and wind passing up by the œsophagus; occasional pains also occur in the stomach, the effect of spasm.

DCCXLVIII.

Solution of the Stomach.

On examining the great end of the stomach after death, from the action of the gastric fluid, there its coats appear thin, transparent, and pulpy; and at times the stomach has been completely dissolved by the same cause, and its contents effused into the abdomen. In the same way it is known to act on the neighbouring viscera, which suffer a partial solution. This effect only happens in those who have died in health, and whose stomachs have not been impaired by disease.

Fatty tumours, biliary calculi, and pustular appearances, are also met with, though very rarely, on examining the stomach after death.

DCCXLIX.

MORBID CHANGES OF THE INTESTINES.

Inflammation.

A variety of causes induce inflammation here; and the appearance which such inflammation produces is, first, an increased vascularity of its surface, which extends also through all its coats, being frequently attended with bloody extravasation. While the intestine is thus altered, the

peritonæum is often little affected; but, at other times, it is also inflamed, and covered with coagulable lymph, which is frequently thrown out upon the surface of the villous membrane. In more violent cases, the intestine receives an additional thickness and weight, with its colour much darkened from extravasation, so as almost to resemble gangrene.

Inflammation of the intestine commonly passes into a secondary stage, or suppuration, and ulceration, particularly where the inflammation attacks the internal membrane; and this secondary state never commences on the external membrane. The great intestines are more subject to this termination of it than the small ones.

Ulceration of the intestines is attended with considerable variety in its appearance, displaying at one time a thickened ragged edge, at other times being little changed from the internal appearance, and sometimes smooth, as if a section had been made with a knife. In the progress, the inner membrane hangs frequently in shreds, or is stripped entirely from the intestine, leaving the muscular surface bare. Ulceration of the intestine either terminates by erosion, so that the intestinal contents pass into the abdominal cavity, or adhesion is formed by the ulcerative inflammation to some neighbouring part, and thus a new communication or passage is established. Such commu-

nication is generally the means of supporting life longer than otherwise.

From its peculiar secretion and structure, the inner intestinal membrane is more subject to ulceration than any other in the body. But, instead of ulceration, a more common termination of intestinal inflammation is by gangrene, the part assuming a black livid colour, and losing all tenacity, which is the chief mark, more than the colour, of this state. The consequence of gangrene here, is the formation and accumulation of a considerable quantity of air in the intestinal cavity. The gangrenous part, when completely mortified, has been known to separate from the rest, and, though fatal in the event, to be expelled by the anus.

Symptoms.

Inflammation of the intestines is known by acute abdominal pain, vomiting and costiveness, with heat and thirst. The pulse here is generally frequent, small, and hard.

DCCL.

Intussusception of the Intestines.

This affection consists in the passage of one portion of the gut within another for some length, dragging after it its part of the mesentery; and the received portion is commonly in a contracted state, being, for the most part, an upper portion falling into an under one; though this is not ~~is~~ the case. The most frequent sort of in-

Intussusception is the small intestine, particularly where the ilium terminates in the colon. Intussusception is sometimes disentangled by the natural peristaltic action, but more frequently from the degree of inflammation the parts thicken, and are glued by adhesions producing fatal obstruction of the passage of the intestine.

Symptoms.

Intussusception, in its advanced stage, is marked by the same symptoms as intestinal inflammation; but, from the state of the parts, and their forming adhesions in consequence of inflammation, it is more fatal.

DCCLI.

Concretions.

Several concretions are met with in the intestines, and they are by no means a rare occurrence. Most of them have nuclei, and we may suppose them in others, where they seem to be wanting; for we can imagine a clot of blood to serve as a nucleus which may afterwards shrink, so that we can scarcely perceive it on cutting the ball. In order to give some kind of idea of one way in which such balls may be formed, we perceive in balls taken from the stomach of a cow, that they are plainly composed of hairs that are always of the same colour with those on the surface, and these are formed by the animal licking itself; the hairs are determined to the throat part.

by the rugæ of the mouth, &c. and so come to be collected in the stomach. In like manner we may imagine concretions formed within ourselves, but we are not to imagine that the undigested and fibrous part of the aliment alone forms the concretions, there may be such an attraction of the nucleus to parts of the aliment as takes place in the vesica urinaria: so within our alimentary canal are found the incrusted seeds of gooseberries, and several concretions which resemble gall stones, or such concretions as are found in the salivary ducts. If we suppose these to form in the stomach, yet they scarcely stop till they come very low, and are most frequently found in the great intestines, particularly in the beginning of the colon, in the caput coli more especially, or in the caput cæcum coli, where they are very much out of the circulation of the food, and the caput coli is sometimes found at the same time of very considerable size.

Symptoms.

We could judge of this disease, if a person, without seeming to have any great weakness in the stomach, or being subject to nervous complaints, has a frequent pain. If this is situated in one particular part of the intestines, and remains there for a considerable time, if it comes in an uncertain manner, without the patient being able find a cause, that no error is committed in diet; at time, perhaps, the patient has a loose belly,

at another time there is a total stoppage, and that made mechanically, by the ball blocking up the passage; soon after which there is perhaps a great discharge of the fœces, and that not without a great deal of pain; and we distinguish particularly a ball of this kind, by the patient feeling a pain upon pressing upon the part, and we can discover a remarkable hardness. If we find that this has very much changed its place, or is situated where no solid bowel is to be found, were it under the left ribs, we might apprehend that it was the point of the spleen in a schirrous state; whereas, if we find it at the side of the umbilicus, we would conclude that it is owing to such a concretion.

DCCLII.

When a ball of this kind has rested long in one place, by inflammation and irritation the coats of the gut are thickened; and the same cause acting, the gut is constricted, though the diameter of the ball is not at first greater than that of the gut: in consequence of this constriction in it, it comes to be impossible for the ball to pass, and there comes to be an adhesion to the containing parts of the belly.

DCCLIII.

Worms.

Next, we meet with different kinds of worms, viz. the tape worm and the ground worm. It has

been imagined that the tape worm was a chain of animals totally distinct from each other. Of ground worms, connected by tenacula; but, by injecting the tape worm, there is a real communication between its joints, so that the whole joints make but one animal, but every joint is at the same time capable of living, as being provided with a mouth, but they live best when connected; for, suppose that some joints do not receive proper aliment, they can receive the nourishment from the superior joints.

DCCLIV.

It has been imagined that it is in a continual state of growing, by fresh additions to the number of joints; but we have no proof of this; and the only question is, Whether the pieces when joined, have at the end one piece different from the rest, by which the animal lays hold of the intestines? and Dr. Tyffon has in a great measure proved this.

DCCLV.

Next, the *lumbricus*, which is essentially and totally different from the earth worm. This is more easily expelled, but it is more dangerous than the former, as preying not only upon the contents, but on the coats of the intestines, eroding great portions of the villous coat. Here, indeed, it generally stops, the other coats resisting it from their greater hardness, and containing less of its nourishment; but, in some cases, these too

are found eroded and perforated, and we are not to conceive that this happens after death when the animal is uneasy, and wants to escape, for we have instances where this worm has made its way through abscesses.

DCCLVI.

Next, the *ascaris*, which appears only a young lumbricus, and not a distinct species. It has been represented as having two heads, as it bursts from the corrugation occasioned by its being kept in spirits, but in shape it approaches near to the lumbricus, and we have found them existing at the same time.

DCCLVII.

Ruptures, or Intestinal Displacement.

A portion of the abdominal viscera is frequently carried out of the cavity from some sudden violent exertion, and lodged in a sac of elongated peritonæum, forming what is termed a rupture. This disease is so frequent, that one out of every eleven is calculated to labour under it; and though every part of the abdominal contents may be occasionally displaced in this way, the omentum and intestines are most frequently so. The most common places of this displacement, are the rings of the muscles of the abdomen where the spermatic chord passes, and the round ligament in the female, or behind that ring at the lower edge of the external oblique, where the vessels pass down to the thigh.

The bowels that will most readily fall out, are;

1. The turns of the intestinum ilium, the mesentery lengthening as we go downwards, so that, besides the end of the ilium being nearer to the ring, the mesentery is longer.

2. The omentum, which is the part most frequently found in the hernial sac, and it may carry along with it the large and loose arch of the colon.

3. The great sac of the colon may fall down from the weight of the fœces pushing it gradually lower down, and bringing it nearer to the rings of the muscles as life advances, so that elderly people are particularly subject to this complaint.

When the omentum has remained long in the sac, it forms a pretty compact mass, for the most part, though not always adhering to the inner surface of the sac; and, though occasionally without inflammation, at other times it is so violent as to produce gangrene.

Along with the omentum, a portion of the intestine is often lodged in the sac, and often the intestine is lodged itself, without any omentum. The size of the portion varies in different cases; and where the functions come to be interrupted by the pressure of the ring, or opening of the sac, so as to induce inflammation, the disease often ends fatally.

The appearances of inflammation here are the same as formerly described; and its assuming the

state of gangrene is marked by its deep and livid colour, by its want of tenacity, and its distension with air. When the inflammation terminates favourably, still adhesions form, which attach the gut for ever after to the inner surface of the sac.

The sac, or containing part, when first descending, is a thin opake membrane, of a firm texture, and white colour, being merely the peritonæum somewhat thickened by pressure. In cases, however, of long standing, its structure becomes changed; and, in consequence of thickening, it is divisible into several layers. Internally, its surface is smooth, and is extended from the inner coat of the peritonæum. Externally, the surface is rough and irregular, and, at the ring, it possesses a narrow neck, corresponding to the situation of the parts.

Symptoms.

Rupture is marked by a pale swelling at the seat of the displacement, with a slight occasional pain in it, diffused over the belly, and the swelling protruding with every exertion; by its disappearance in the horizontal posture, and its admitting being pushed up, though not always when of long standing.

DCCLVIII.

In the stage of strangulation, to these general symptoms are to be added those of inflammation, or most distressing sickness, vomiting, obstinate

costiveness, with heat, thirst, and frequent small hard pulse, ending in hiccup, and the appearance of yellow foetid matter from the mouth. In some cases, however, the pulse is little increased.

DCCLIX.

Congenital Rupture

Differs from the other in the sac being the same with that of the testicles, arising from the opening at the ring not closing at birth, after the descent of the testicles, and a portion of the intestine, or omentum, falling into the elongated portion of the peritonæum.

Symptoms.

The chief mark of this species, is its appearance coëval with birth.

DCCLX.

Schirrus and Cancer of the Intestines.

This affection is most frequent in the large intestines in advanced life, and its most common seat is the sigmoid plexus of the colon or rectum; and this proceeds from the greater glandular structure, and the narrowness of the gut at the former part. The disease is commonly here very circumscribed, though it has been known to extend some inches; and it differs in nothing from the appearance assumed by the stomach under the same disease. The coats acquire a thickness and hardness; the internal one, especially, is formed into hard irregular folds, and they are in general divided by

membranous septa. The ulceration of the inner surface, in this state, produces cancer; and, in the advanced stage of the malady, the structure of the gut is changed into a gristly hardness. The consequence of schirrus is a contraction of the passage of the gut, which becomes at times almost obliterated; and above this contraction, it is enlarged in the same proportion from the accumulation that necessarily takes place. Another consequence of this affection, is the formation of adhesions between it and the neighbouring viscera, occasioning ulceration to spread.

Symptoms.

The progress of this disease is at first slow, and there is little pain in the part, the patient only observing a costiveness, and some difficulty in the passage of the stools. In time, pain comes to be felt in the part on stool, after which it becomes relieved. In the stools, pus and blood is occasionally mixed, especially towards the termination of the malady. The fallow countenance is here a leading mark of the disease, with much general debility and quickness of pulse. The constitution gradually failing, the patient is at last cut off.

DCCLXI.

Dysenteric Intestine.

The gut is here considerably thickened with irregular tubercles of a white or yellowish colour, and frequently there appears an abrasion of the

cccl MORBID ANATOMY.

inner membrane. But the most frequent appearance in fatal dysentery is increased vascularity and ulceration of the inner membrane.

Symptoms.

The symptoms of dysentery are griping, and often most acute pains of the belly, frequent evacuations of various matters, as mucus, pus, blood, membranous fibres, white lumps, and hardened fæces. Tenesmus is a constant symptom after stool, and there is frequently more or less general fever.

DCCLXII.

Thickened Rugated Membrane.

This appearance consisting in the great intestine formed into broad thick folds, containing an accumulation of blood, is a rare occurrence. On examination, it is found an accumulation of cellular matter behind the gut. Above the anus, also, little processes sometimes grow from the inner membrane, forming a circle across the gut.

Symptoms.

These changes are distinguished by no peculiar external marks.

DCCLXIII.

Piles.

Piles and ulcerations of the anus are common diseases. The former are soft tumors of various shapes, situated round the verge of the anus, covered with a fine skin, partly derived from the

external covering of the anus, and partly from the inner membrane of the gut. Though entire, through these tumors much blood is often discharged, and they consist of the veins round the anus much enlarged.

Such tumors also form within the rectum, termed internal piles, occasioned by an enlargement of the veins, frequent in advanced life, which is the common period of their attack. They are the effect of long continued obstruction to the return of the blood from the rectum. On this account they are more frequent in women than in men, in consequence of such obstruction laid by pregnancy, and from the greater tendency in women to costiveness from their mode of life.

Symptoms.

Piles are easily known by external swellings at the anus, or within the rectum, by pain in their seat on the passage of the feces, by an occasional flow of blood, and sense of irritation in the part; and these local symptoms are often preceded by constitutional symptoms of turgescence, as giddiness, dyspnœa, colic, and lumbar pains.

DCCLXIV.

Fistula.

Fistulæ are seated at the lower end of the rectum. They are narrow canals, with a smooth internal surface, possessing a purulent secretion, and terminating externally by a callous edge. The

canal is either single, or divided into branches. It has an external opening by the side of the anus, frequently a small one into the gut, and at times one at both extremities. The first, however, is most common.

Symptoms.

No external symptoms mark this disease.

DCCLXV.

Malconformation of the Rectum.

Some instances of the malconformation of the rectum occur by its terminating in a third sac, without any external opening; and on perforation of the part, the end of the gut is found at some distance. The strong tendency of the parts to contract afterwards, is always against the success of an operation.

In the same way the rectum is known, at times, to terminate in the bladder, which admits no relief; and occasionally, though rare, in the vagina.

DCCLXVI.

Worms.

Worms occupy the intestines of man, as well as those of other animals; and they are confined, as already noticed, to three species, the lumbricus teres, the tenia, and the ascaris.

Symptoms.

The symptoms attending the presence of worms here, are swelling of the belly, offensive breath, emaciation of the extremities, and deranged ap-

petite, with picking of the nose, and grinding of the teeth in sleep. Thus the appetite is at times very great, at other times very small, and the stools are generally slimy.

The symptoms of the tenia are, a gnawing in the region of the stomach, lessened or removed by eating, irregular appetite, as in the former, itching of the nose and giddiness, nausea, and cholic; at times, cough and convulsions.

The marks of ascarides are, uneasy feeling of the rectum, and itching of the anus; with heat, tenesmus, and mucous stools mixed with blood or ascarides.

DCCLXVII.

Accumulation of Air.

An accumulation of air in the intestines is attended with slight peritonæal inflammation; and the intestinal vessels are frequently filled with it. This either arises from the contents of these parts being extricated by the process of digestion, or it is secreted by the vessels, and poured out here, which is more probable, as being found to consist mostly of carbonic acid gas.

Symptoms.

The marks of this accumulation are, some abdominal swelling, often shifting its place, and attended with a kind of gurgling noise; costiveness, and occasional cholic. When largely accumulated, it forms tympany, known by the tense elastic feeling

of the swelling, by some dyspnœa, by severe cholic and costiveness, and by occasional discharge of flatus both upwards and downwards.

DCCLXVIII.

Osseous Accumulation.

An osseous matter has been at times seen thrown out upon the surface of the inner membrane of the gut; and even an adhesion of the intestine, in two points, has been seen converted into bone. Thus an osseous matter is capable of being deposited by secretion in any part of the body. Calculous matter has been also mentioned as occasionally occurring in the intestines.

DCCLXIX.

Inflamed Mesentery.

This is generally conjoined with that of the peritonæum; and under inflammation the mesentery becomes thick and massy, and its large vessels are much obscured from the extravasation of coagulable lymph, while the vascularity of the adjacent peritonæum is increased.

Pus is occasionally found on the mesenteric surface, and abscesses between its layers; but these circumstances are rather uncommon. It seldom extends beyond simple inflammation, except where gangrene of the intestines occurs, and it partakes in the same state.

Symptoms.

The symptoms of this affection are the same

with those of the peritonæum, and cannot be disjoined.

DCCLXX.

Morbid State of the Mesenteric Glands.

The mesenteric glands are apt to assume three different species of morbid disposition, viz. a scrofulous, cancerous, and earthy one.

1. The first is most frequent in children, where they become enlarged in size, and somewhat softer than natural to the touch, displaying, on dissection, either the natural structure, or a change in part into a white, soft, curdy matter, not uncommonly mixed with pus.

2. The second differs nothing in appearance from schirrus elsewhere, and is commonly the consequence of a cancerous affection of the intestines.

3. The third is an accumulation of earthy or osseous matter in the glands, which is, indeed, a rare occurrence, compared with its appearance in those of the lungs.

Symptoms.

The marks of enlarged mesenteric glands are, a swelled belly, and emaciation of the extremities, with the constitutional appearance of scrofula, and no traces of worms.

Hydatids and fatty tumors attached to the mesentery are rare appearances, though they have been enumerated.

DCCLXXI.

MORBID CHANGES OF THE LIVER.

External Membrane inflamed.

This affection is often conjoined with that of the peritonæum. It occurs, however, without this connection; and though it spreads, at times, over the whole of the organ, yet it more commonly affects only its anterior convex part, sometimes the side next the stomach and duodenum. The appearances here are the same as in the peritonæum, an increased vascularity occurs, and also a thickness of its substance, with a layer of coagulable lymph thrown out, differing in thickness in different cases, and glueing the organ more or less to the adjacent parts. A serous fluid is also sometimes effused.

Symptoms.

The symptoms are much the same with those of pleurisy, acute pain of the lower part of the right side, dyspnæa, cough, and symptomatic fever.

DCCLXXII.

Adhesion.

The consequence of hepatic inflammation is the forming adhesions, which arises from the organization of the coagulable lymph thrown out. This organization forms it into a thin transparent membrane, which connects the organ with the adjacent parts. This connection is either general over the surface, or consists of different small processes.

The mode of adhesion is occasionally by a long membrane, at other times by a close attachment. The anterior part of the liver is the most common seat of those attachments. In cases of adults, those adhesions prevent the diffusion of pus in the abdomen. The posterior part of the liver is, at times, connected to the stomach and duodenum, and adhesion there will have a similar effect as in the former case of abscess.

Symptoms.

No peculiar external symptoms lead to a knowledge of adhesions.

DCCLXXIII.

The coats of the liver suffer, at times, a partial conversion into cartilage, which is smooth, thin, and of a softish texture. This, however, is a rare circumstance, and can be previously ascertained by no symptoms.

DCCLXXIV.

Inflammation of the Liver.

This affection is peculiar almost to a warm climate, while that of its coats occurs in a cold one. This inflammation of the organ is attended with an enlargement of its size, and a deep purple colour of its substance, with a general jaundiced colour of the skin. Its outer membrane is not always affected by this state of inflammation. The progress of this inflammation is to terminate by abscess; and this abscess is often so large as to contain some

pints of matter. Sometimes the whole liver is converted into this containing bag; and the disease is generally accompanied by ascites, the fluid of which is of a yellow or green colour, from the tinge of the bile. Gangrene of the liver is a very rare occurrence, if ever taking place.

Symptoms.

Inflammation of the liver is marked by obtuse pain in the right hypochondrium, rising to the top of the shoulder, by difficult recumbence on the sound side, by a dry cough, with hiccup and vomiting, by an occasional jaundiced appearance, and in general by symptomatic fever; though, when slow in its progress, both pain and fever are at times unknown; and its presence is only detected by the formation of an abscess.

DCCLXXV.

Tubercles.

A frequent disease of the liver is, the formation of tubercles, especially in men from middle to advanced age who are addicted to excess in drink; and these tubercles are diffused generally over the whole organ, of a rounded shape, and situated near each other. By this affection, the hepatic surface is every where irregular, and their dissection exhibits a brownish or yellowish white matter. Their most common size is that of hazel

its, though known occasionally as small as a pin

With this irregularity, the liver feels hard

to the touch, especially at the lower edge, which is bent a little forwards. Its size is, however, generally diminished on the whole; and its vessels, when it is cut into, shew a lessened diameter. Its colour is frequently yellow, and water is found in the abdominal cavity of the same tinge. The gall bladder is generally contracted, white, and empty; and the chest is yellow, or suffused with bile.

Symptoms.

The symptoms of schirrous liver are, pain or uneasy feeling in its region, continuing long, and attended at last with jaundice and water in the abdomen. This state of the organ, at its lower edge, can at times be felt when the abdominal accumulation is small.

DCCLXXVI.

Besides this common state of tubercles, other varieties occur, which are of three kinds, the white, the brown, and the scrofulous.

1. The first of these, which are rare, equal in size a chestnut. They are seated most commonly near its surface, two or three together, while the intermediate space of the organ is free from disease. They consist of firm, opaque, white substance, depressed and hollow in the outer parts, forming as it were round the blood vessels; and, when they occur, the organ is increased in size with or without abdominal accumulation; and,

in the same way, with or without a change of colour.

2. The second species of tubercles is, the soft brown, which is not so large as the former, but occupies the same situation, and consists of a smooth, soft, brownish matter.

3. The third species is the scrofulous tubercle, resembling entirely those of the lungs; but this appearance is very rare, and these tubercles are dispersed regularly through the substance of the liver, without producing any irregularity of its surface. At times, with such tumours, the liver is found more flaccid in its substance than is natural. In such cases of flaccidity, the liver has been found also very soft.

DCCLXXVII.

Morbid Hardness.

A general hardened state of the liver occasionally appears, which, when cut into, discovers no other peculiar morbid change. This is considered by some as the previous stage of tubercles.

Symptoms.

Hardness of liver is distinguished by no peculiar marks, but there will prevail in its progress some uneasiness or weight in its region, joined with a fallow appearance of the countenance.

DCCLXXVIII.

Hydatids.

No organ is so much the seat of hydatids as the

liver and kidneys. In the former, they are contained in a firm cyst, often of considerable size, having externally a cartilaginous feel, and laminated to appearance within, with various degrees of thickness in different cases. The external surface of the cyst consists of a white matter, the internal of a pulpy substance, similar to coagulable lymph. The number of hydatids in a cyst is various. They lie loose in its cavity, swimming in a fluid, or attached to the side of the chest; and they are composed of a white opaque pulpy matter, having much contractile power, with a fluid capable of being coagulated; and these hydatids contain often within them smaller ones, either loose or attached to their sides, as in the larger ones. These hydatids of the liver are often unconnected; but, at other times, they seem to inclose each other. The cyst is most commonly within the substance of the liver, though occasionally attached to its outer surface, and hanging from it into the abdomen.

Symptoms.

No peculiar symptoms characterise this disease, and conjecture can only be made of its existence. This conjecture is formed by the gradual formation of a tumor in the region of the liver, by its having little influence on the general health, by its giving to the feel a certain sense of softness without fluctuation, or rather an obscure one, and

by its being traced particularly from the liver as its origin.

DCCLXXIX.

Offeous Depositions.

Cysts containing an earthy matter are at times to be met with in the liver. The cyst, in this case, is of a cartilaginous consistence, and its contents are an earthy matter, of a brownish white colour. This affection can be learnt by no external marks.

DCCLXXX.

Rupture.

Strong pressure upon the liver is found to occasion its rupture; for, instead of recovering its former state after the removal of the pressure, as happens to parts of a more elastic structure, the softness of its texture occasions it to give way. This accident is attended with little pain; but, from the derangement of the circulation, death in a short time succeeds it.

DCCLXXXI.

Worms.

Worms are a rare appearance in the liver, though they have been noticed here, as well as in several of the other viscera.

DCCLXXXII.

From this view of the diseased state of the liver, its organic changes appear numerous, and the following observations contain the sum of what claims attention on the subject.

DCCLXXXIII.

Vesicles we have found in large sacs, and within each of the larger we find smaller. Now, this appearance, though it occurs most frequently in the liver, yet it is to be observed in various other places, but especially in the abdominal viscera. Till within these few years, these very generally were taken for portions of cellular substance, formed by concretions of the cellular membrane. But Dr. Pallas, an ingenious naturalist, conceives that they are animated bodies; which opinion was first hinted by Dr. Tyson in the last century; and, upon the whole, his idea is just, though in several respects he errs in calling them *tenia hydatidea*. He supposes that it is an animal somewhat like to that in the intestines, and that this produces hydatids; but no such connection can be observed; and it may be doubted that the *tenia* is constantly sending off new joints, or adding to its number, which is a very discouraging opinion; for, after we have separated hundreds of joints, it may still form new ones; but by killing joints, we kill a part of the animal, and there is no growth again. And there is a greater probability that they are animated substances, from our finding clusters of round bodies within each other adhering to the outer skin, which we must take to be the parts of the young growing, and that when they have acquired a certain bulk they separate;

and the second having the small structure as the first, contain others, and so on *ad infinitum*; and it only remains to prove that they are living animals, that we distinguish their motions; but they have no manner of communication with the cellular substance, nor have they vessels painting them, so they can only live by fluids poured in from the arterial system; and we find other worms in the liver, the origin of which we can as little explain. There is a species of worm found in sheep that die of the rot, and, perhaps, this is the cause of the rot, as in marshy grounds the disease is more common. We find within the gall ducts a worm of a particular kind, which feeds on bile. From its mouth branches are dispersed, like the branches of an artery, and are all filled with bile; so that the mouth of the animal is its aorta, and the branches are propagated to the most distant parts.

DCCLXXXIV.

When the liver is in a schirrous state, it is sometimes lessened in its bulk. De Haen gives an instance of a schirrous liver not bigger than the fist, but, for the most part, it is bigger; and in the interstices of the vessels we find deposited a sebaceous-like matter, and knots scattered unequally through it; and we can generally distinguish the schirrous by laying the hand on the edge of the the thorax, and particularly about the

middle, as we can generally first feel it under the cartilago eniformis. The size is sometimes very great, descending half way to the umbilicus, and even half way between the umbilicus and os pubis, and yet without dropsy.

DCCLXXXV.

Should a suppuration happen in the liver, a consequence of inflammation, we ought to attend to all the possible ways in which the pus can be discharged. In a sound person the liver is covered in its under part by the peritonæum, upon which the bowels play freely, and it adheres to the containing parts by its ligaments; but the inflammation breeds adhesions in the neighbourhood: by the suppuration the liver is enlarged, descends under the edge of the thorax, and the abscess frequently adheres to the peritonæum lining the muscles; so if an opening is made under the edge of the thorax, we get into the cavity of the abscess without opening the cavity of the abdomen; but if the abscess is within the edge of the thorax, it may make its way through the diaphragm; and as this is almost contiguous to the pleura, it being thickened and inflamed, may come to adhere to the side; and the matter eroding, this may make its way outwards, or into the lungs, if they come to adhere. Cases of this kind have occurred, where bile has been thrown up by coughing, or it may come to adhere to the parts immediately beneath,

to the stomach, and to the great arch of the colon; and we have many examples in practice, where abscesses of the liver were freely discharged by vomiting and stool; or, the matter may get into the cavity of the alimentary canal, by the erosion of the biliary ducts; and where the matter is very deep in the liver, the matter may find its way into the gall bladder, which has been found distended with purulent matter: or, supposing the abscess to burst into the cavity of the abdomen, the matter may fall down into the pelvis, and resting on the rectum, may inflame and erode it, and so get out of the body.

DCCLXXXVI.

MORBID CHANGES OF THE GALL BLADDER.

Inflammation.

The coats here, when inflamed, are connected with the inflammation of the membrane of the liver, which is spread over the gall bladder, and thus communicates its affections more or less to it. No peculiar appearances distinguish this inflammation from the same affection of the stomach and intestines.

Symptoms.

The symptoms are the same with those which attend the membranous inflammation of the liver.

DCCLXXXVII.

Adhesion.

Dissections show frequent adhesions of the gall

bladder to the end of the stomach, or beginning of the duodenum, being the effect of previous inflammation. This admits no external symptoms.

DCCLXXXVIII.

Ulceration.

Ulceration of the gall bladder, though met with, is a very rare occurrence, and begins in the inner membrane, while the other coats do not appear affected. Neither does it appear to be much an effect of gall stones. We have no external information to detect this morbid change.

DCCLXXXIX.

Tubercles.

Tuberculous state of the liver is sometimes, though rare, communicated to the gall bladder, when its coats also are considerably thickened; and, in the same way, a solitary instance or two has been observed of the coats being converted into an ossous matter.

DCCXC.

Dilatation of the Ducts.

The three ducts are often found dilated to an amazing size, near the extent of an inch in the transverse diameter. This is the effect of the passage of gall stones, which often descend, of a very great size, into the duodenum.

DCCXCI.

Obliteration of the Ducts.

This appearance is very rare, but it has oc-

curred, and may be referred, wherever it takes place, to one or other of the following causes :

1. Violent inflammation of the inner surface of the ducts producing adhesion.

2. The same state of the duodenum involving the ductus communis choledochus.

3. Schirrus of the round head of the pancreas acting by pressure on the same duct.

Symptoms.

The chief symptoms of this state will be permanent jaundice, which may equally arise from a tuberculous state of the liver.

DCCXCII.

Passage between the Gall Bladder and the Stomach.

A deviation from the common structure has been met with in a communication, by a short canal between the gall bladder and small extremity of the stomach.

DCCXCIII.

Gall Stones.

Stones in the gall bladder, or ducts, are a frequent appearance on dissection ; and the bladder is often largely distended by them, with its coats proportionally thickened. The existence of a single stone is marked by its oval shape, that of a number by their many sides and angles. In their internal appearance, gall stones differ in their colour, in their internal texture, and in their properties. With regard to the first, their colour is

of considerable variety, as white, black, and all the intermediate gradations between these two extremes. In their external appearance they differ, some being smooth in their surface, and others a good deal tuberculated. Their internal texture is made up of concentric laminæ, within which there appears a radiated structure. But the proportion of these to each other varies in different calculi, and also the looseness and compactness of the matter of which each is composed. Chemical experiments shew the constituent principles, and consequently the properties of gall stones are somewhat different.

Symptoms.

The presence of gall stones is only detected when they attempt to pass the ducts; and then, if large, they create most excruciating pain about the pit of the stomach, with languor, sickness, and vomiting, yellow suffusion of the skin, but the pulse is little accelerated.

DCCXCIV.

Bile.

The most common appearance of the bile is that of a brownish yellow colour, with a certain viscosity greater in man than in other animals. It is changed by disease at times into a ropy fluid like mucus; and it is even found deprived of colour like the white of an egg. A tuberculated liver, and enlarged mesenteric glands, attend this change. From the transuding of the bile through the biliary coats after death, the stomach and

duodenum appear always on dissection tinged with this secretion. Accumulation of bile producing distension of the organ, and also a defect of it, attended with contraction of that viscus, are morbid states occasionally met with. Hydatids also, in this situation, are stated as an occurrence, though rare. Even the gall bladder has been found wanting in cases of malconformation.

DCCXCV.

MORBID CHANGES OF THE SPLEEN.

Inflammation of the Coats.

The coats of the spleen are affected with inflammation, only from the affection of the peritonæum. In this state they exhibit an increased vascularity, a more thickened texture, and a deposition of coagulable lymph on their surface.

Symptoms.

The symptoms of this affection are, pain of the left hypochondrium, more or less acute, increased on pressure, with symptomatic fever and difficult respiration.

DCCXCVI.

Adhesions.

Adhesions of the spleen to the neighbouring viscera are often met with, formed by a firm white membrane, and thus it is found attached to the diaphragm, great end of the stomach, and arch of the colon. These adhesions are marked by no external symptoms.

DCCXCVII.

Inflamed Substance.

This affection is so rare that it may be barely noticed.

Symptoms.

The marks of this state described are, a fullness and sense of pain in the left hypochondrium, increased on pressure, with general fever. The sense of pain has been also mentioned as diffused over the abdomen.

DCCXCVIII.

Morbid Softness and Hardness.

The spleen is found in two opposite states, either of preternatural softness or hardness. The former of these is to such a degree that, on breaking the capsule, its substance seems to consist of a brownish red mucus, intermixed with spongy fibrous texture. It is peculiar to middle and advanced life, but is distinguished by no peculiar symptoms. The latter, or its hardened state, is generally attended with an enlargement, so as at times to exceed its proper size by 5 or 6 times, when it can be easily distinguished by the external feel; and it shews also in this state a greater compactness of structure. Water in the abdomen often attends this affection.

Symptoms.

The symptoms of this disease are only distinguishable externally, in its advanced stage, by the

situation and shape of the tumor, its anterior edge being felt irregular under the margin of the ribs on the left side. Ascites also is found present.*

DCCXCIX.

Tubercles.

Scrofulous tubercles occasionally appear on the spleen, similar to those on the lungs; but no peculiar symptoms distinguish them.

DCCC.

Cartilaginous Coats.

This is a common disease of the spleen, the covering of its convex surface suffering more or less this change. It varies in thickness in different cases, resembling, in appearance, the cartilage of the nose, consisting of a small layer, but at times irregular. The process must naturally be slow, and hence no peculiar symptoms indicate the change.

DCCCI.

Enlargement.

Enlargement of the spleen, without disease, is a frequent appearance, and requires therefore only to be noticed.

DCCCII.

Hydatids.

Hydatids affect the spleen in the same manner as the liver, though less frequently.

Symptoms.

The marks of this affection are, pain of the left

hypochondrium, with swelling spreading slowly into the cavity of the abdomen, having a softness to the feel, and sense of obscure fluctuation.

DCCCH.

Concretions, &c.

Stony concretions have been noticed as an appearance observable in the spleen at times. Its rupture, also, has occasionally occurred in consequence of external pressure, though this can only take place when it is much enlarged. A species of peculiarity is also marked at times in the structure of this organ, being an appearance of several small spleens, as well as the large one. Some of these equal in size a walnut, are situated in the omentum, and derive their circulation from the splenic artery and vein. This organ has been likewise found wanting at times, and no difference has been experienced in the apparent state of health or exercise of the vital functions.

DCCIV.

MORBID CHANGES OF THE PANCREAS.

These are fewer than in most of the other organs, as dissections evince.

DCCV.

Abscess.

Abscess, however, here, has been met with, attended with an enlargement of the organ, and the discharge of a considerable quantity of pus.

Symptoms.

The symptoms of this affection are, more a diffused pain of the abdomen than fixed in the seat of the organ. Spasms of the intestines and abdomen also attend, and sickness, and diarrhæa. Pains of the back and loins have been also noticed.

DCCCVI.

Hardness.

A hardness of this organ, with its thickened state, and shortened in size, is a common appearance, and seems the commencement of its schirrus. When actual schirrus takes place, its structure is enlarged and changed into a uniform white mass, intersected by membranes as elsewhere.

Symptoms.

This state, when advanced, has been marked by continued pain in the epigastric region, and sickness at the stomach, with a sense of hip pain, and numbness of one leg and thigh.

DCCCVII.

Calculi.

Calculi, of a white colour, are formed in the duct of this organ, and have been found equal in size to a hazel nut. They are easily dissolved in the muriatic acid, and therefore differ from urinary calculi.

Symptoms.

The symptoms of calculi here, can only be those which commonly attend irritation; but they

possess no peculiar marks of discrimination, so as to ascertain the existence of the disease.

DCCCVIII.

Defect.

This organ has been found wanting in some rare instances.

DCCCIX.

DISEASED STATE OF THE KIDNEYS.

Inflamed Capsule.

The inflammation here is a rare occurrence, from its loose connection with the peritonæum. When it happens, the same appearances will be exhibited as in inflammation elsewhere.

Symptoms.

Inflammation of the kidneys is marked by pain felt in their situation, shooting along the course of the ureters, with a sense of numbness in the thigh, or retraction or pain in the testicle. The symptoms are only felt in the side affected. The discharge of urine varies in colour, being mostly of a deep red. Sickness and vomiting attend here, as also costiveness, and occasionally cholic, joined with symptomatic fever.

DCCCX.

Abscess.

Inflammation of the kidneys terminates in supuration and abscess more frequently than that of any other gland in the body, and these abscesses possess a scrofulous disposition, appearing in the

form of one or two circumscribed sores, full of curdy matter. The inner surface is also lined occasionally with a pulpy matter.

The effect of such abscesses is to destroy, first, the mamillary portion, and afterwards, in their progress, the whole structure of the kidney, so as to change it into capsules surrounding a number of morbid cavities; and the capsules are frequently thick, laminated, and of considerable thickness. In its progress the affection generally extends to the pelvis and ureter.

Symptoms.

The formation of abscess in the kidney known by the mixture of pus with the urine; the quantity of pus will soon determine the state of the affection.

DCCCXI

Tubercles.

A tuberculous state of the kidney is very rare. Where it appears, it resembles, in its appearance, the tubercle of the lungs.

Symptoms.

No external symptoms discriminate this affection.

DCCCXII.

Schirrus.

Schirrus of the kidney exhibits a plain, brown, uniform substance, intersected by membranes, and is an enlargement of the gland. It is, however, a rare appearance here; and where it occurs in.

the whole of the kidney it must be attended with the very worst species of dropsy. If the disease occurs from a schirrus of the liver, it is formed of the milder parts of the blood, and the water is tolerable, however when the matter passing by the urine is excreted into the cavities of the body most readily yielding to it, and even in the ventricles of the brain which frequently is the case, it must be attended with the worst consequences; and when the obstruction is lower, the effect is nearly the same as when it is in the kidney itself.

Symptoms.

The symptoms have never been justly discriminated.

CCCXIII.

Diabetic State.

Diabetic kidneys shew an increased vascularity of structure with the superficial veins, displaying a fullness of their contents, and forming a net-work. The appearance of the kidneys in this disease is much like that of inflammation. A quantity of whitish fluid, resembling pus, is also collected in the substance of the kidney.

Symptoms.

The symptoms of diabetes are, the increased quantity of urine or a sweetish taste and watery colour, great thirst, and voracious appetite; with an increase of pulse, and gradual emaciation.

DCCCXIV.

Softness.

The kidney appears, at times, converted into a loose mass, like a sponge; and this spongy structure is found, on dissection, to pervade every part of it. This is a peculiar process, by which part of its substance is absorbed, and the cortical part in this absorption suffers most.

Symptoms.

No general symptoms can detect this peculiar state.

DCCCXV.

Hydatids.

Hydatids in the kidneys are not so common as in the liver. One or two large ones, however, are sometimes conspicuous on its surface, situated between its substance and capsule, and occasionally their number is even greater. They are of a pulpy nature, with thin coverings, the same as any other membrane, and they are found here also only of one size. But the true hepatic hydatid is also to be met with in the kidney, occasioning a change of the whole internal structure of the organ, and contained in a thick laminated bag, often of a cartilaginous hardness. Being of different sizes, from that of an orange to not more than the head of a pin, some of them have been voided by urine, occasioning much exertion in the bladder to expel them, and producing, of course,

an increased thickness of its muscular coat, like other causes of obstruction.

Symptoms.

The only symptoms here are, pain felt in the loins during the formation of the disease, along with symptomatic fever, nausea, and vomiting; but these attend also affections from another cause, so that the passage of the hydatids by the urethra is the only certain criterion of their existence.

DCCCXVI.

Calculi.

The kidneys are the most frequent seat of calculi, and they appear lodged either in its body, or in the pelvis of the ureter; where, by their stay, increasing in size by new depositions, they assume from the shape of their situation an arborescent form. In their colour, they are either white, or assume different shades of brown; and their surface, though at times smooth, is for the most part roughened and irregular. The obstruction they form to the passage of the urine, occasions an alteration in the structure of the organ, the pelvis and cavity of the kidney becoming very much enlarged; and the ureter also suffers a change in the same manner, according to the particular part of the organ at which the calculus occasions an obstruction. So enlarged does the kidney at last become, as to lose entirely every appearance of its natural structure,

and to consist solely of a capsule containing a number of cells; yet, even with this loss of structure, the powers of secretion in the organ still remain entire as before, and the urine is separated in the same quantity, and entirely of the same nature.

As a calculus occurring here is a frequent cause of inflammation in the kidney, perhaps an inflammation here disposes to the growth of calculi; several circumstances lead to that notion. Some persons are more subject to calculous concretions than others, and there is no doubt a constitution that disposes to it; this is chiefly in the kidney; and a morbid change may be made by inflammation, which gives that disposition. It begins to be formed long before the urine is extravasated. Small particles of calculi are observed within the tubuli; and, as the inflammation is often evidently brought on by calculi; so, if such persons get cold, or are affected by intemperance, there is an uneasiness of the kidney, and a discharge of sand, and here the pain of the kidney seems to be the consequence of this want of attention.

Symptoms.

The symptoms of calculi, and those of inflammation, are much the same, except that in the former there is a deposition of red crystals on the discharge of urine, an occasional mixture of blood, and an increased pain of the loins on motion.

DCCCXVII.

Qzification.

The change of the kidneys into earth and officous matter, has been stated by authors; but these are appearances that must be extremely rare, and barely deserve notice.

DCCCXVIII.

The kidneys display much variety from original formation, both in their situation and structure, being occasionally joined together, or before the lumbar vertebrae, or at the sides of the pelvis; and in some instances they are very small, or this is only on one side, and the other is enlarged. Sometimes the kidney of one side is wanting.

DCCCXIX.

Morbid Changes of the Renal Capsules.

These are rarely affected by disease. An instance or two of their abscess has been stated, and also their swelling from a scrofulous cause; for their enlargement, and their being filled with a white matter, shewed such a disposition. Their conversion into cartilage, and even the appearance of stony particles in their substance, has been also detected.

DCCCXX.

DISEASES OF THE BLADDER.

Inflammation of the Peritoneal Coat. :

Inflammation only takes place here when it is

general over the membrane, and it is usually confined to it, and does not extend to the other coats of the bladder from its loose connection to them, and the interposition of cellular matter. A consequence of this inflammation is adhesion of the bladder to the neighbouring parts, in the male to the rectum, and in the female to the womb.

Symptoms.

The symptoms are chiefly pain and heat in the region of the bladder, without much influence on the functions of the organ.

DCCCXXI.

Inflammation of the Bladder.

The inflammation of the inner membrane is more or less extensive, from its spreading over the whole organ to its affecting merely a particular part; and, when partial, the vicinity of the neck is generally the seat of it. The appearance of this inflammation consists in an increased vascularity, and frequently extravasation of blood. The muscular coat, however, is commonly not affected.

Symptoms.

This affection is attended with pain and fullness in the peritonæum, or above the pubes, with frequent small and painful micturitions, or a total retention of the discharge, attended with urgent desire. Tenesmus of the rectum also takes place, and the stomach sympathizes, being affected with sickness

and vomiting. Not unfrequently delirium prevails. The formation of pus is marked by its appearance in the urine discharged.

DCCCXXII.

Ulceration.

This is often a consequence of the former affection terminating in suppuration; and when ulcers are of the common kind, no peculiar circumstances mark their appearance here. In their effects, a portion of the bladder is often destroyed, and communications are thus formed between it and the neighbouring parts, either with the abdominal cavity, or the rectum in the male, or vagina in the female. The consequence of the first is general peritonæal inflammation; of the two last, much irritation and pain, and the disease often continuing for life.

Local violence is generally the cause of abscess here, and particularly the operation of lithotomy. In some cases, the inner membranes of the bladder has been entirely separated by the process of apparently scrofulous ulceration.

Symptoms.

The symptoms of ulceration here are marked by pain and difficulty in making water; and where communications are opened by ulceration, the passage of the urine detects these; and the pain and irritation, from affecting the parts it pervades.

DCCCXXIII.

Scirrus and Cancer.

These diseases are only communicated here from neighbouring parts, and are seldom original, being extended either from the rectum or uterus. In this situation they are characterised by the same thickness and hardness as when affecting other parts, and communications necessarily prevail with these parts.

DCCCXXIV.

Fungus.

Fungus appears on the inner surface of the bladder, either in one mass, or detached pieces, which seem composed of a loose fibrous texture. If situated behind the neck, obstruction of the urine is the consequence; and a stronger action required to expel it, occasions a thickening of the muscular coat.

Symptoms.

The difficult discharge of urine is the only symptom of fungus; and if it is situated near the neck, it may perhaps be ascertained by the introduction of the sound, which touching it, will give the feeling of a soft tumor; and an examination of the rectum will mark its distinction from a diseased prostate.

DCCCXXV.

Polypus.

* Polypus of the bladder has been observed, con-

sisting in various irregular projecting masses of a firm texture; but this appearance is very rare, and the symptoms are the same with those of the fungus.

DCCCXXVI.

Elongation of the inner membrane forming irregular processes in certain parts, consisting of much cellular membrane intermixed with fat, is an appearance observable in the bladder at times.

Symptoms.

This disease must be slow in its progress; neither will any inconvenience attend it, unless it presses on the neck, when a difficulty of water will ensue.

LCC CXXVII.

Cysts.

Cysts of various sizes are found intimately connected with the bladder, and opening into its cavity. They are mostly pouches turned from the bladder itself, though they are often found of a prodigious size.

DCCCXXVIII.

Thickens of the Muscular Coat.

This is the common consequence of all diseases where the action of the bladder is much increased. From $\frac{1}{4}$ inch, its natural thickness, it is increased at times to half an inch; still retaining, however, its pale colour, without any additional redness, and having between the fasciculi, or its inner fibres,

little pouches from the inner membrane. These pouches equal at times, in size, the extremity of the little finger, and small calculi are contained in them. This is more a disease of the male than of the female.

Symptoms.

The symptoms of this disease are, frequent inclination to void urine, from the small capacity of the bladder to contain it.

DCCCXXIX.

Division of the Cavity.

The bladder has been observed divided into two chambers, an upper and a lower one, separated by firm membranous substance, and having an aperture of communication.

Symptoms.

The symptoms of this disease in its advanced state are, a considerable circumscribed tumor above the pubes in the situation of the distended bladder, a lessened discharge of urine, and no way affecting the size of the tumor when discharged. At times, a large emission of urine, from the choice of some particular attitude, enabling it to descend into the lower chamber, and the tumor of the pubes subsiding in consequence of this, with a release of symptoms till a new accumulation.

DCCCXXX.

Calculi.

Calculi are a frequent disease in the bladder,

affecting the male oftener than the female, and conspicuous at every period of life. The origin of this affection is either from the kidneys descending by the ureters, or it is found in the bladder itself. An extraneous substance, forming a nucleus, is sometimes the cause of these calculi, either loose, or confined to a particular part of the organ. In the latter case, they are sometimes lodged in cysts formed by the inner membrane, or attached to an excrescence of the bladder, retaining it in that situation. Where one calculus only exists, it is commonly of an oval form; where more, they acquire by friction flat sides and angles. In general, the surface of calculi is granulated, from which they acquire a certain degree of roughness, and this roughness varies in different cases, according to the size of the granules; occasionally, instead of this, the surface appears of a porous structure. The division of calculi exhibits a laminated texture in concentric curves compactly applied, and varying in the thickness of the laminæ. At times, also, a porous structure is conspicuous. The colour of calculi is very various, but brown chiefly prevails, of different degrees; and the colour of the same calculus varies in different places, the outside being of one colour, and the inside of another. Both the specific gravity of different calculi, as well as their chemical qualities, differ widely from each other;

and though the matter of calculus is thus found in the bladder, for the most part formed into one or more rounded masses, there are instances when the whole of its cavity is filled with a substance like mortar.

Symptoms.

The symptoms of calculus are well ascertained, and consist of an uneasiness at the orifice of the urethra after the discharge of urine, or any exertion, with more or less of a dull pain at the neck of the bladder. Frequent micturition also takes place, passing either in drops, or with the stream suddenly suspended. The urine displays a large deposition of mucus, and is also occasionally tinged with blood. Tenesmus is likewise a common symptom.

DCCCXXXI.

Dilension and Contraction.

Dilension of the bladder occupying the lower part of the abdomen, is a very common appearance on dissection; and, in an opposite extreme, it is also discovered at times so contracted, as hardly to display any cavity arising from its strong action before death.

DCCCXXXII.

Defect of the Anterior Part.

A want of this part occasionally appears; the place of which is supplied by a soft, vascular, fleshy texture, externally situated on the abdomen,

and formed of projecting masses, having on them a layer of thick ropy mucus. On this mass the ureters open, and it is attended with malconformation in the parts of generation.

DCCCXXXIII.

Communication with the Rectum.

A connection of the rectum with the dependent part of the bladder is sometimes met with, being the effect of original malconformation; and another, though a rare appearance, is the bladder being found lodged in a hernial sac, both at the abdominal ring and under Poupart's ligament.

DCCCXXXIV.

MORBID CHANGES OF THE MALE GENITAL PARTS.

Inflammation of the Vesiculæ Seminales.

The vesiculæ seminales are occasionally the subject of disease, though it is difficult to detect it. Their inflammation is generally derived from that of the contiguous parts; and, in consequence of this, adhesions have been formed by them; and likewise suppuration has taken place in their substance.

Symptoms.

No peculiar symptoms can mark inflammation here distinct from that of the other contiguous parts.

DCCCXXXV.

Scrofulous Accumulation.

The appearance of a scrofulous matter has also been traced in the vesiculæ seminales.

DCCCXXXVI.

Malconformation, &c.

The ducts of the vesiculæ feminales are occasionally wanting, or do not open into the cavity of the prostate gland. By the semen being thus prevented from passing into the urethra, sterility must be the natural consequence. A morbid smallness of their structure has been also detected, rendering them unfit for the execution of their functions, though one is often found smaller than the other. Even one of them has appeared wanting, in which case the vas deferens of that side being enlarged and tortuous, has probably supplied its place. Schirrus and calculi of these parts have been also noticed.

Symptoms.

None of these affections have been distinguished by any leading symptoms in the living body, and dissection only has made known their existence.

DCCCXXXVII.

DISEASES OF THE PROSTATE GLAND.

Abscess.

The appearance of abscess in the prostate gland shews its being subject to the common attack and progress of inflammation, and this abscess possesses nothing peculiar more than abscess of other parts.

Symptoms.

The marks of inflammation here will be pains more or less acute at the neck of the bladder,

with difficulty in making water, and some tenemus; and the quick progress and acuteness of pain will distinguish it from schirrus.

DCCCXXXVIII.

Scrofula.

The prostate, on dissection, often discloses the same curdy matter as in other scrofulous glands; and pus has been pressed from it in this state.

DCCCXXXIX.

Schirrus.

Schirrus, however, is the most common affection of the prostate gland; and the consequence of this is, its enlargement to equal the size of the fist, displaying on dissection the marks of schirrus elsewhere, or a firm white or brown substance, intersected by membranous septa in various directions. In this state, its posterior extremity projects deep into the cavity of the bladder, by which the urinary discharge is interrupted from entering the urethra, and that in a greater or less degree, according to the extent of this projection. Where this is very great, an instrument cannot be passed, and an artificial passage is sometimes made by the side of the gland. In this way life is often protracted under this disease. The gland, also, often assumes an irregular growth, and a winding passage is formed through it by the change in the shape of its cavity, which increases the difficulty of making water. Not unfrequently with its en-

largement its surface becomes ulcerated, and a fistula occasionally appears between it and the rectum. From a diseased prostate gland the bladder naturally suffers; and being excited constantly to extraordinary exertions, its substance becomes thickened and stronger. This affection is a disease of advanced life.

Symptoms.

The marks of a diseased prostate gland are, difficult micturition, and in small quantity, sometimes a total suppression of it. The same uneasiness attends the passage of the secret, and a continuance of the desire after it is over. Mucus from the urethra frequently follows these evacuations, from the exertion employed. The introduction of a bougie or catheter detects the disease by the place of its stoppage.

DCCCXLI.

Calculi.

Small brown calculi of the size of a pea are occasionally found in the ducts of the prostate, and consist chiefly of phosphate of lime.

Symptoms.

The only symptoms here will be difficulty of urine, and the feeling to a sound, or catheter, of a stone impacted in the neck of the bladder.

DCCCXLI.

Enlarged Ducts.

The enlargement of the gland, and wideness of

its ducts, so as to equal the size of a small quill, sometimes appears. This state is always the effect of stricture in the urethra, which obstructing the passage of the urine, occasions its accumulation behind, and its dilatation of these parts; while the bladder itself suffers from the same cause, and a thickening of it also attends this affection.

DCCCXLII.

Præternatural Smallness.

The prostate gland has been found in an opposite extreme præternaturally small, so as to be unfit for performing its functions. But this malconformation was extended to other parts of the genital system.

DCCCXLIII.

MORBID CHANGES OF THE URETHRA.

Abscess.

The membranous part of this passage is the seat of abscess, and it may arise from external or internal causes; but obstruction of the urethra from stricture is the most frequent source of this malady. By the irritation of the urine behind the stricture, inflammation and its consequences are induced, and an abscess breaking externally, the urine is discharged through the aperture.

Symptoms.

Stricture of the urethra is marked by more or less difficulty in the discharge of urine, which is in a small forked stream, scattered as it were; and

often it passes in drops. Some gleet appearance likewise attends. Various symptoms arise in the contiguous parts from sympathy, and constitutional irritation is frequently connected with the local affection.

DCCCXLIV.

Fistula.

The continuance of the former affection, with no disposition to heal, constitutes fistula here; or the parts acquire a thickened hardness, and the lips of the orifice turn callous. The most common seat of this disease is behind the scrotum, or near the membranous division of the urethra; and these fistulæ frequently display several openings into short canals, which run in various directions.

Symptoms.

This affection is conspicuous by the external symptoms.

DCCCXLV.

Calculi.

By the compaction of calculi, the membranous part of the urethra is formed into a bag, often so large as to contain a small egg; and, by the contact of the urine, the calculus in this situation gradually increases, as elsewhere. The marks of this state are evident on external examination.

DCCCXLVI.

Cowper's Glands.

Cowper's glands have been mentioned as changed

into ligament; but dissections seldom shew them the subjects of disease.

DCCCXLVII.

Inflamed Membrane.

The inflammation of the inner urethral membrane is similar to that of other secretory membranes. It displays in this state an increased vascularity, and an augmented secretion of its glands. The seat of this inflammation is generally at its anterior extremity, but the inflammation spreads through its whole surface; nor is it confined to the membrane alone, but spreads into the substance of the spongy parts, affecting its whole structure. The consequence of its thus extending is increased thickness and hardness of these parts, and the deposition of coagulable lymph into the cells, which thus acquire a more vascular state. Even the glands become augmented, and feel like round tubercles to the finger.

Symptoms.

External symptoms mark sufficiently this state of disease.

DCCCXLVIII.

*Ulcers.**

This is a very rare appearance in the urethra, as the inflammation here seldom extends that length.

Symptoms.

Much pain at a particular part, and a discharge*

from it mixed with blood, will give some evidence of this state.

DCCCXLIX.

Stricture.

Stricture was formerly noticed as the most frequent affection of this part, by which the canal is partially narrowed, or altogether obliterated. Its most common seat is a little anterior to the membranous division of the urethra; and here it exhibits various appearances, as consisting either in a simple approximation of the opposite sides of the passage, or in its contraction for a certain extent, either attended with the apparent natural state of its surface, or its thickening and hardness, with a partial abrasion or ulceration.

These consequences are often augmented by mechanical attempts at relief, the ulcerations being extended, and not unfrequently even a new passage formed. The stricture also prevails in different places, and is at the same time irregularly placed on one side, so as to give obliquity to the passage.

Symptoms.

The symptoms of this affection were already detailed as a cause of inflammation.

DCCCL.

Caruncle.

An excrescence from the urethra is a rare occurrence. In scrofulous constitutions, however,

MORBID ANATOMY. cccxcvii

it is occasionally observable on dissection, and therefore falls to be noticed.

Symptoms.

The symptoms of this affection cannot differ from those of stricture.

DCCCLI.

Earthy Matter.

The deposition of an earthy matter in the bladder, formerly noticed, may be even extended here; and, accordingly, a thin layer of this substance has been found to pervade the whole canal.

DCCCLII.

Malconformation of the Orifice.

The external opening of the urethra is sometimes found to be placed under the frænum, or where it should be, for in such cases no frænum exists. The opening here is also smaller than the natural one. Some other species of malconformation are at times met with, but they are very rare.

DCCCLIII.

DISEASED TESTICLES.

Hydrocele.

A collection of water in the vaginal coat of the testicle occurs at every period of life; but after manhood, it seldom suffers a spontaneous termination. A pyramidal bag, more or less thickened and laminated, approaching the ring of the abdominal muscle, and extending at times to the ring

itself, is its common appearance. By this accumulation the testicle suffers compression. The fluid contained possesses the properties of the serum, and from undergoing a morbid change, acquires a yellowish, greenish, or brown colour.

Symptoms.

The symptoms of this affection are determined by the pyramidal shape of the swelling, by its want of pain, by its resistance on pressure, by its having no influence on the general health, and by its transparency to the eye, when it is opposed to the light of a candle placed on the other side of it, or at least by its compressibility, where the thickening of the coat prevents this transparency being so distinct.

DCCCLIV.

Hydatids.

This appearance has occasionally been found within the vaginal coat, both loose, and in a state of adhesion; but the affection is rare.

Symptoms.

The marks of this affection will be the same as hydrocele, but its peculiar nature can only be distinctly known by opening the swelling.

DCCCLV.

Cartilages.

The vaginal coat is also at times the seat of cartilaginous substances, loosely placed in the cavity, and of the same nature as those appearing

occasionally in the joints, from a deranged secretion of the vessels.

Symptoms.

As they are productive of no great inconvenience, no peculiar symptoms mark their presence.

DCCCLVI.

Adhesion.

The vaginal coat becomes closely attached to the testicle by a firm adhesion, either through its whole extent, or only in detached points, varying in their thickness of texture. They are always the consequence of previous inflammation of the part.

DCCCLVII.

Inflammation of the Testicle.

This gland is often subject to inflammation, which varies no way in appearance from that of other parts. The inflammation generally extends to the vas deferens and the spermatic cord, which occasions a thickening of the coats of the former, and the veins of the latter sometimes acquire a varicose state. The inflammation is often succeeded by a permanent hardness and swelling of the epididymis, arising from extravasation during the height of inflammation.

Symptoms.

Inflammation here is distinguished by the uniform smooth swelling, by the rapidity of the inflammation, and by the inflammatory blush or rosy colour of the teguments.

DCCCLVIII.

Abscess.

Abscess here is a consequence of inflammation, though not so frequent as in other parts; but it possesses here no peculiarities.

DCCCLIX.

Scrofula.

Scrofula here changes the testicle into an enlarged mass, which, when cut into, displays a white or yellowish curdy substance, mixed with pus in a greater or less degree.

Symptoms.

The chief marks of this disease are, a softness of texture, a slight pain in the part, and a general healthy state of the system.

DCCCLX.

Pulpy State.

The natural structure of the testicle often degenerates into an entire brown, uniform, pulpy matter. This is a peculiar disease, equally distinct from scrofula and schirrus.

Symptoms.

The symptoms are the same as those which mark scrofula.

DCCCLXI.

Schirrus and Cancer.

A brownish hard mass, intersected in various degrees by membranes, characterizes schirrus of this gland, where the natural structure is lost in

cells containing a sanious fluid, with an occasional mixture of cartilages. In the progress of the disease, the appendages of the testicle, or the epididymis and the spermatic cord, take on the same morbid disposition. The ulceration of this mass, and its producing a fungous growth, constitutes cancer.

Symptoms.

The chief marks of this disease are, its great hardness, and darting pain extending along the cord, joined to its slow progress and particular influence on the general health. In the ulcerated state the symptoms are obvious.

DCCCLXII.

Cartilage and Bone.

In some schirrous cases a predominance of cartilaginous substance prevails, marked by ulceration in its centre; and this cartilage differs in nothing from common cartilage. A partial appearance of osseous matter in the testicle has also, at times, been met with.

DCCCLXIII.

Malconformation of the Epididymis.

The termination of the epididymis in the vas deferens has been wanting at times. By this defect, the semen not being expelled into the urethra, sterility must be the consequence. Stricture of the vas deferens also occurring from disease, must be attended with the same effect in regard to one testicle.

DCCCLXIV.

Smallness and Wasting.

Smallness in the testicle, which sometimes takes place in an extreme degree, is always attended with a want of venereal inclination. Wasting of the testicle also occurs as an effect of disease, either of inflammation or compression. This wasting has been known in both testicles. When occurring only in one, the natural powers continue as before. When one testicle does not descend at birth, but is continued in the abdomen, which sometimes happens, it remains of an imperfect size in that situation.

DCCCLXV.

Morbid Changes of the Spermatic Chord.

The spermatic chord is liable to four different affections: schirrus, scrofula, varix, and dropsy.

The first of these is generally conjoined with that of the testicle, by the affection of which it is changed into a hard mass of the same nature with the testicle itself, and at last its effects extend to the lumbar glands.

The second is derived from the same source as the scrofulous state of the testicle, and exhibits the same appearance in the change of its structure.

The third, or varix, is very common to this situation, and it takes place in the veins of the chord in various degrees, from simple enlargement to the most distended varicose state. The chord

then becomes a bulky mass, diminished on pressure, and very soft to the feel. From this increase of the parts above, a wasting of the testicle often ensues.

The fourth, or water, is found in this situation in two different places, either diffused in the cellular membrane of the chord forming a local anasarca, and readily diminished on pressure, though accumulated here to the quantity of some pints; or, what is more common, the water here is encysted and lodged in a sac of the spermatic chord, formed by a firm white membrane full of serous fluid.

Symptoms.

In the encysted kind, the testicle is found under the swelling distinct and separate, in which it differs from hydrocele.

DCCCLXVI.

MORBID CHANGES OF THE FEMALE GENITAL SYSTEM.

Uterine Affections.

Inflammation.

The inflammation of the uterus is generally a consequence of parturition, when occurring; and its affection is extended, more or less, over the peritonæum. Its appearances are the same with those of inflammation elsewhere, and its fundus and body are the chief seat of this morbid state. In its progress, it extends along the uterine appendages, and not unfrequently uterine inflam-

mation terminates in abscess, with pus collected in the large uterine veins. The peritonæal affection, conjoined with this, appears the same as under other morbid circumstances, only there is here a proportionally greater extravasation of coagulable lymph.

Symptoms.

The marks of inflammation here are, hypogastric pain and tension, increased on pressure or-examination of the uterine orifice. The stomach sympathizing, vomiting ensues, attended with an irregular state of the bowels, general fever, and much frequency of pulse. On the peritonæal affection being considerable, added to these symptoms, swelling of the abdominal cavity takes place, with increased pain and tenderness.

DCCCLXVII.

Ulceration.

The seat of this morbid change is the neck of the uterus, from which it spreads to the fundus, so as to destroy the greater part of the organ, and convert it into a tattered mass. From the uterus, it frequently spreads also to the contiguous parts, particularly to the vagina, bladder, and rectum, with all which it forms communications. In its first stage, the uterus becomes by it somewhat harder, and enlarged. The chief period of its attack is middle and advanced life, though it is occasionally met with in young subjects.

Symptoms.

Pain, more or less exquisite, in the part, with a purulent or bloody discharge, forms the leading symptom of the disease. Its progress, where communications take place with neighbouring parts, particularly the bladder, is marked by the discharge of urine from that situation. A small frequent pulse, fallow look, and great emaciation, attend the advance of this malady, and swelling of the inguinal glands from absorption.

DCCCLXVIII.

Schirrus.

A general scirrhus enlargement and hardness of the uterus, to equal in size gestation at six months, often occurs, shewing on dissection a hard substance of a brownish or brownish white colour, intersected by membranes. An ulceration and tuberculous state of its inner surface is a frequent effect of its progress, and these tubercles contained in its substance are similar in structure to the uterus itself.

Symptoms.

This disease is only known in its advanced stage by more or less acute in the hypogastric region; and by an examination of the state of the uterus, by the vagina feeling at the orifice hard and enlarged, with a considerable weight of the organ when raised on the finger. Not unfrequently the enlargement may be felt by application of the

hand above the pubes. A discharge will be joined with these symptoms when it has passed into ulceration.

DCCCCLXIX.

Tubercles.

An external tuberculous state of the uterus, as well as an internal, the effect of schirrus, is at times discovered. These tubercles vary much in size, being irregular in shape, and knotted. When cut into, they shew the same general appearance as schirrus. One peculiarity is their small tendency to ulceration. Instead of numerous tubercles, the uterine cavity is often filled by one large mass of this kind, which exhibits, on dissection, the same structure, and which is connected to the uterus only by loose cellular membrane, while, except in its enlargement accommodated to the size of this mass, the organ is not otherwise affected by disease.

Symptoms.

No symptoms mark this affection in its early state, and, in its advanced progress, it is no way to be distinguished from schirrus.

DCCCCLXX.

Polypus.

This is the same disease as the tubercle, only it differs in the manner of its connection with the organ, adhering always to it by a small neck. These polypi vary in size, from a walnut to the

magnitude of a child's head. The fundus is the most common seat of attachment, and more than one are generally found at a time in the uterus. Sometimes they differ from the tubercle, and consist of a mere loose bloody mass, with tattered processes from it. This mass, when opened, is formed either of a spongy laminated substance, divided by interstitial cavities, or of the same texture with larger ones. By these polypi the size of the organ is augmented in proportion to their bulk.

Symptoms.

Pains of the loins, with mucous and occasional bloody discharges, are the leading symptoms here, till it is distinguishable by examination. The general health is little affected.

DCCCLXXI.

Inversion.

Inversion is the effect of a polypus, or the extraction of the placenta. In the first case it is partial when there is an appearance of fissure on the outside, and the uterine appendages are drawn inwards at both edges of the fissure. In the second case, the inversion is complete, and the inner surface expands, while the fundus forms a large tumor within the vagina, and even extends without the os externum.

Symptoms.

The symptoms of incomplete inversion can only

be guessed at from the excess of the discharge. When complete, examination will ascertain it.

DCCCLXXII.

Prolapsus.

A displaced uterus, by the yielding of the ligaments, occurs in those who have a large pelvis, or where the soft parts are much relaxed by labor. By this means it falls down, so as to occupy the external parts, or appears without them.

Symptoms.

This affection is obvious on examination.

DCCCLXXIII.

Stricture, &c.

Stricture occurs at that part of the uterus where the fundus ends in the cervix. The parts become here glued by some slight inflammation, or gradually approach each other so as to shut up the aperture. In the same way, the os uteri has been found closed up by the growth of a membrane, and its opening obliterated. A bony state of the uterus has been also known, from a morbid secretion of its vessels. It has likewise been changed into an earthy substance. Bone has also been found in its cavity, arising probably from a tubercle assuming this state; and stones have not unfrequently occupied the same situation, varying in their colour, and corresponding to concretions in other glandular parts of the body. Even a dead foetus has been changed into an earthy matter by

remaining a long time in this cavity, still preserving its original shape.

DCCCLXXIV.

Water.

Dropfy of the uterus is a difeafe in which a large accumulation has at times taken place, even to the extent of 100 pints, the fluid poffeffing a bloody or yellowifh appearance, and being ferous as in other cafes. A ftricture of the cervix always attends this morbid ftate.

Symptoms.

The evacuation of water only afcertains the certainty of this ftate.

DCCCLXXV.

Hydatids.

Hydatids of the uterus differ from thofe in other fituations. They confift of veficles of a round oval fhape, having each a narrow ftalk by which they adhere to each other. They differ much in fize, from a walnut to a pin's head, and the larger poffefs fmall ones adhering to them by narrow proceffes. It is probable they are connected with impregnation.

Symptoms.

No marks can difcriminate this morbid ftate till the expulfion of the hydatids, when it is attended with pains refembling thofe of labor.

DCCCLXXVI.

Rupture.

Rupture of the uterus is an accident occasionally taking place at the end of pregnancy, or in the course of labor. The side of the uterus is generally the seat of it; and where the peritonæum remains entire, there is accumulated between it and the rupture much black coagulated blood, having much the appearance as if gangrene had taken place.

Symptoms.

The symptoms of this accident, though it is only certainly known by examination, are, pain, with a feeling in the belly of something giving way, chocolate coloured vomiting, suspension of labor pains, and a retraction of the prevesting part.

DCCCLXXVII.

Varieties.

The size and thickness of the uterus varies in different cases, and also its situation being placed more or less laterally in the pelvis. A double uterus has also occurred as an instance of mal-conformation.

DCCCLXXVIII.

**MORBID CHANGES OF THE UTERINE APPENDAGES
ON THE OVARIA.**

Inflammation of the Coats.

Inflammation of the peritonæal covering of the

ovaria arises from its connection with other parts, and is never original. When assuming this state, it displays the same appearance as inflammation elsewhere; and the consequence of this is the adhesion of the ovaria to the neighbouring parts.

DCCCLXXIX.

Inflamed Substance.

This only arises from inflammation of the uterus, and by this inflammation the ovaria become enlarged, hard, and vascular. Frequently pus is formed in them.

Symptoms.

The same symptoms attend this affection as that of the uterus.

DCCCLXXX.

Schirrus.

Schirrus is a less frequent affection of the ovaria than of the uterus. By its attack they are changed into an enlarged, hard, white mass, intersected, as in other parts, by membrane; and not unfrequently the change into hardness proceeds the length of bone, with a greater proportion of earth in it than common bone.

Symptoms.

Schirrus here can never be determined but in a very advanced progress of the disease.

DCCCLXXXI.

Softness.

The ovaria becomes at times enlarged and

changed into a brown pulp, with cells containing a fluid. Much the same appearance takes place when they assume a scrofulous state.

DCCCLXXXII.

Dropfy.

The chief disease of the ovaria is dropfy, the whole substance being destroyed, and changed into a bag containing a fluid. The size of this is often large, firm, and white in its texture, while its fluid is capable of being in part coagulated. In this bag a number of cells are often also found, which communicate with each other, and at other times cysts are found that have no communication. The size of these cysts is various, from a hazel nut to an orange; and their coats vary in their degree of thickness, and in the number and compactness of their laminæ. The fluid they contain is of various consistence, from serum to jelly; and it is not the same in every cyst. These cysts adhere by broad surfaces to each other, and are only the natural structure of the ovaria enlarged.

Symptoms.

Dropfy of the ovarium, when advanced, is marked by an abdominal tumor on one side, with an unequal surface and obscure fluctuation, the general health little affected, and the urine no ways diminished.

DCCCLXXXIII.

Extraneous Productions.

The conversion of the ovaria into a fatty substance, having teeth and hair in it, is a singular change that at times occurs. They are inclosed by a capsule of a white, strong membrane. The hairs lie loose in the fat, or adhere to the capsule. The teeth here want fangs; they are connected to the inner membrane of the capsule, or an irregular bony mass. The origin of these productions are as yet inexplicable, though they do not appear connected with impregnation.

DCCCLXXXIV.

Fœtus.

An ovarial fœtus is a frequent appearance. It never arrives at any great size. The structure of the ovarium becomes changed into a bag of some firmness; and on the inside of the bag is attached the placenta, and part of the chorion. On this bag the Fallopian tube and spermatics can be traced. The uterus assumes the impregnated state by an enlargement at the same time, and formation of decidua. Its vessels are also augmented.

DCCCLXXXV.

Shrinking.

Age diminishes the ovaria to half their size, and renders them hard and tuberculated. Their vesicles, in this state, are found filled with a white solid matter.

DCCCLXXXVI.

Defect.

The ovaria have been found wanting at times on both sides, and occasionally on one.

DCCCLXXXVII.

On the Fallopian Tubes.

The changes which the Fallopian tubes undergo, are similar to those of the ovarium. Thus inflammation is communicated to them from the uterus, and even their suppuration takes place. Adhesions are formed by them, in consequence of inflammation, to the neighbouring parts, and particularly the fimbriated extremity of the tube is found adhering to the ovarium, or its structure and aperture are entirely lost. Dropsy also, from the adhesion of its two extremities, ensues. The aperture of the tubes is likewise at times wanting from malconformation, and an ovium has even been detained here in its descent, and increased in the tube to a considerable size, while the uterus is augmented, and receives all the other changes that take place, as if it had been deposited there. The tube is even subject to assume the tuberculous state, and to possess a growth of a firm white substance, intersected by septa the same as the uterus.

DCCCLXXXVIII.

On Round Ligaments.

These parts are exposed to the progress of in-

flammation from the uterus, and other affections which have been particularly noticed.

DCCCLXXXIX.

DISEASES OF THE VAGINA.

Inflammation.

Inflammation of the internal surface, near the os externum, is common from a venereal cause.

Symptoms.

The symptoms are such as constitute gonorrhœa.

DCCCXC.

Adhesion.

The effect of violent inflammation is, adhesion of the sides, more or less general; but it is mostly partial, and constitutes stricture.

Symptoms.

The marks of this are known by examination, and they may be previously suspected by the absence of the menses, and the inability of sexual intercourse.

DCCCXCI.

Ulceration.

Ulceration is here in various degrees, from a single spot on the internal surface to a foul ragged sore. These ulcers frequently arise from the uterus, and in their progress communications are formed by them with the neighbouring parts, particularly the bladder and rectum, which embitter existence.

Symptoms.

Examination is the surest means of their detection, and they are attended with more or less pain, and a purulent discharge.

DCCCXCII.

Schirrus.

Schirrus occurs here also without the same state of the uterus, and nothing peculiar distinguishes its appearance here from what has been described elsewhere.

Symptoms.

The chief symptoms of it are, the glassy, painful, hardened feel, which the affected part assumes.

DCCCXCIII.

Inversion.

Inversion or prolapsus here, is a frequent disease, produced by a wide pelvis, and a relaxed state of the soft parts, particularly the os externum. It is either complete or incomplete. When it is without the external parts, it displays different shapes, forming either a large rounded mass, or being narrow and elongated, so as to extend some way from the surface of the body. This appearance constitutes a species of hermaphroditism. Where long inverted, the parts acquire a hardness, and inflammation and ulceration occasionally arise. Adhesion is also formed, while the uterus is in this prolapsed state, with the neighbouring parts, which

renders their reduction extremely difficult, and sometimes impossible.

Symptoms.

This complaint is marked by a sense of bearing down, and the passing up of a tumor through the vagina in the erect posture. Examination, however, is the surest test.

DCCCXCIV.

Deviations.

Three different deviations of the vagina from the natural dimensions, merit to be noticed.

1. The 1st is its shortness to half its natural length, which is the effect of malconformation, and is only known by examination.

2. The 2^d is its extreme wideness, from the previous dilatation of polypi that have been removed; and,

3. The 3^d is narrowness; which, in a morbid degree, is generally the effect of malconformation.

DCCCXCV.

MORBID APPEARANCES OF THE EXTERNAL PARTS.

Imperforated Hymen.

The conclusion of the vagina at its external extremity, is by means of a firm membrane, the effect of original formation, generally discovered at the period of menstruation, in consequence of the accumulation then taking place.

Symptoms.

Its symptoms consist in strong bearing down.

pain, first occurring at every menstrual period, and then departing; at last they become more continued as the accumulation, and of course the uterine irritation, increases.

DCCCXCVI.

Enlarged Clitoris.

This menstrosity is often at birth larger than the penis of a male child, with a prepuce glans, and an external fissure, so as to imitate the appearance of the male. In its progress, however, the increase is not equal to the increase of the penis. An accurate examination of the general state of the parts will detect the real nature of the malconformation.

DCCCXCVII.

Enlarged Nymphae.

This enlargement sometimes occurs in one, and sometimes in both. When extended so as to pass beyond the labia, the structure becomes changed similar to that of the labia, and it is inconvenient from the effects of friction.

DCCCXC VIII.

Adhesion of the Labia.

The labia are found united in two ways, either by a fine line not extended to the meatus urinæ and glans of the clitoris, or they are joined by a continuation of the common skin, by which the labial appearance is lost. The parts here are the common seat of inflammation and ulceration from

a venereal cause, but these merit no particular investigation.

DCCCXCIX.

MORBID CHANGES OF THE BRAIN AND ITS
MEMBRANES.*Inflammation of the Dura Mater.*

The appearances exhibited by the dura mater in a state of inflammation are, its increased vascularity, though this never takes place in a high degree from its natural structure; the lining of its inner surface with coagulable lymph, which is not frequent; and an adhesion between it and the other membranes of the brain to a certain extent; though this is also rare. Inflammation here often terminates by suppuration. Pus is found covering it, and even gangrene at times ensues. Ulceration, also, is a frequent appearance.

Symptoms.

The marks of this morbid state are, pain of the head, delirium, general fever, and sometimes convulsions, or a tendency to these.

DCCCC.

Attachment of Extraneous Substances.

The dura mater has at times tumors proceeding from it of a scrofulous or spongy nature, the former being distinguished by the curdy pus on dissection, the latter by their soft pulpy feel and apparent fibrous texture. Even bony laminæ are apt to form here, thin and irregular in their shape,

of various sizes, and confined generally to the longitudinal sinus or its falx, with a greater proportion of earth than common in their substance. The number of these ossifications varies, and even the falx has assumed entirely this state.

Symptoms.

The symptoms of tumor are marked by long-continued pain of the head, occasional delirium, or convulsions, not unfrequently apoplexy.

When bone forms the cause, convulsions are more frequent, with continued pain of the head, and occasional delirium.

DCCCCI.

Adhesion.

Morbid adhesion is a frequent appearance here, and is probably the effect of previous inflammation. It prevails so strongly as to divide the membrane on attempting to separate it into two layers, one adhering to the cranium, the other to the pia mater.

Symptoms.

No peculiar symptoms mark this.

DCCCCII.

Thickness of the Arachnoid Coat.

This is the only morbid appearance remarked here, and along with it a serous fluid is found interposed between it and the pia mater.

DCCCCIII.

Venous Turgidity of the Pia Mater.

This appearance occurs without marks of inflammation, and is the consequence of the obstruction of the blood in its passage to the heart, so that the veins here become distended with de-oxydated or black blood.

Symptoms.

Stupor, delirium, and apoplexy, are the attendant symptoms of this state.

DCCCCIV.

Inflammation of the Pia Mater.

Inflammation here is difficult to distinguish from the natural vascular appearance of the membrane. The chief distinctions are drawn from the greater vascularity of its under processes, and their closer adhesion to the brain. Occasionally the formation of pus takes place, effused on its surface, and, more rarely, adhesion between it and the dura mater.

Symptoms.

The symptoms are the same here as inflammation of the other membranes already noticed.

DCCCCV.

Anomalous Appearances of the Pia Mater.

This membrane is subject to the attachment of scrofulous tumors; to the distension of its vessels with air, extricated in a peculiar manner from the circulation; to the adhesion of hydatids to its

substance, and even to the occasional conversion of it into bone.

Symptoms.

None of these circumstances have been characterized by any peculiar symptoms.

DCCCCVI.

DISEASED APPEARANCES OF THE BRAIN.

The morbid appearances of the brain itself may be reduced to real change of structure, or fluid accumulations.

DCCCCVII:

Inflammation.

The first of these changes is inflammation being confined to a small spot, either of it or of the cerebellum, though this effect is rare without external violence. It exhibits only increased vascularity and redness, extending, if on the surface, to the contiguous membranes.

Symptoms.

The symptoms of this state are, pain of the head, delirium, general fever, and coma.

DCCCCVIII.

Abscess.

Abscess of the brain is a frequent consequence of inflammation, by which its texture is broken when the collection is great, or the part ulcerated where it is small.

Symptoms.

The marks of this state are the symptoms of in-

inflammation, with paralysis and convulsions, particularly where it is seated in the tuber annulare, or medulla oblongata.

DCCCCIX.

Gangrene.

Gangrene here is rare, and exhibits a dark brown appearance, with much softness.

DCCCCX.

Softness.

Preternatural softness of the brain is most conspicuous near the lateral ventricles in the medulla of the hemispheres. It attends fatuity in age, and is combined with sanguineous apoplexy.

DCCCCXI.

Firmness.

The opposite state of the former is more common, joined with toughness and elasticity to a great degree; and here an enlargement of the ventricles takes place, with an accumulation of serous fluid. Excessive dryness of the brain has been also noticed, and lightness of the medullary substance.

Symptoms.

Mania has been considered as the leading mark of this state.

DCCCCXII.

Preternatural Formation.

In the substance of the brain, a smooth, uniform, firm, white substance is formed, to which

the brain adheres, with an increased vascularity of its edges. Similar rounded masses appear in different parts of the brain, and in such cases a serous accumulation prevails in the lateral ventricles. This constitutes scrofula of the brain, the substances being occasionally converted into scrofulous matter. Encysted tumors are also at times an appearance in the brain, probably connected with the same cause. Bony tumors have been also noticed, consisting of an irregular mass of osseous processes, filled up by a fleshy interstitial substance.

Symptoms.

The symptoms of these various preternatural affections are, fixed pain or uneasiness in the head, with occasional delirium, convulsions, and apoplexy. If passing on to the optic thalami, defect of vision is conjoined; if to the tuber annulare, or medulla oblongata, convulsion is the most frequent symptom.

DCCCCXIII.

HYDROCEPHALUS, OR WATERY ACCUMULATION.

Internal.

Perhaps the most common disease of the brain is the hydrocephalus, where water is accumulated in its ventricles. It is a disease of childhood, from the moment of birth till near the age of puberty, though its attacks are confined to the three or four first years of life. The quantity of accumulation varies in different cases, from a few

ounces to as many pints. Where it is in excess, by the raising of the anterior end of the fornix, a communication comes to be formed between the lateral ventricles, and from the same cause also it extends into the 3^d and 4th. The accumulation here consists of serum in a purer state than in the other cavities, though the proportion of its coagulable matter varies in different instances. By much accumulation, the structure of the brain is changed more or less into a pulpy mass, or containing bag. The bones of the cranium suffer an extension from this disease, altering, also, in some degree, their shape, and the skull greatly exceeds its usual proportion to the face. The sutures, however, form the chief places of the extension of the cranial cavity; but the bones are also thinned, and their fibres distracted, which display membranous interstices. Such are the changes produced by long continuance of this disease.

Symptoms.

The symptoms of this disease enumerated are, pain of the head, joined with stupor and convulsions, occasional hectic, picking of the nose, and grinding of the teeth; joined, when more advanced, with dilated pupils and squinting. Sickness of the stomach, and costiveness, commonly attend. The pulse, at first frequent and regular, becomes more slow and irregular as the disease proceeds to its last stage.

DCCCCXIV.

External.

The same accumulation has been known on the surface of the brain, confined by the pia mater. It is, however, rare, and perhaps rather conjoined with the former. It has been also known between the cranium and dura mater, and between the dura and pia mater; but these are rarely original states of disease.

DCCCCXV.

Bloody Accumulation.

The effusion of blood is common within many parts of the cranium. It depends generally on rupture; and this effusion may be lodged in the cerebral substance in the ventricles upon the surface of the brain, or within its membranes, according to the particular cause of the rupture.

Effusion here is either attended with a sound or diseased state of the vascular system of the head; and, in the first case, which is the least common, the effusion is the consequence of external violence. The diseased state consists in the large arterial branches of the head losing their power of contraction in consequence of taking on an osseous disposition, and this disposition they communicate to their smaller ramifications. The quantity effused varies, but is often considerable, and in a coagulated state; the pressure of which injures the organ. The seat of the effusion is ofteneft the

medullary part of the hemispheres, and near the lateral ventricles. A morbid softness of the brain also may favour that effusion.

Symptoms.

The symptoms of a membranous effusion are, coma in different degrees; those of an effusion into the cerebral substance are, also, stertorous breathing, and palsy more or less complete, convulsions, with pulse slow, full, and strong. If life continues, these symptoms end in permanent hemiplegia.

DCCCCXVI.

Serous Accumulation.

This is generally confined to the medullary part of the hemispheres, which becomes lined with a firm membrane containing it.

DCCCCXVII.

Aneurism.

The only aneurism within the brain is that of the internal carotid, at the sella turcica. It is connected with the diseased state of the artery; in advanced life is very rare; and the tumor has been found the size of a cherry.

DCCCCXVIII.

Morbid Change of the Choroid Plexus.

Distension of the vein at its edge produces here the appearance of hydatids, in size from a pea to that of a gooseberry. It is an appearance, however, very rare. Scrofulous tumors also, of a

small globular shape, are found attached to this part, and are equally rare.

DCCCCXIX.

Diseases of the Pineal Gland.

The pineal gland is subject to various morbid changes. A deposition of earth is found constantly in its substance, in a greater or less quantity; and a small portion appears without disease. It is also subject to schirrus, acquiring a greater firmness than is natural; and water has even been found to distend its substance.

DCCCCXX.

Diseases of the Pituitary Gland.

This gland has been found enlarged and changed into a somewhat firm fibrous texture.

DCCCCXXI.

Diseased Nerves.

Nerves are seldom found diseased. Where they are, they shrink in size, become softer than natural, and less opaque in colour. In their original structure, however, they vary in different cases in their size.

DCCCCXXIII.

Malconformation of the Brain.

A considerable variety of malconformation in the origin of the nervous system is met with. Often most of the cerebrum is wanting, while the cerebellum and spinal marrow are entire. Sometimes there is little appearance of either of these,

with the medulla spinalis at the same time of a small size, while the nerves in general are of their proper form and size. Where the brain is wanting, the cranium is on a level with the eyes, and has its scalp covered with a soft spongy excrescence, divisible into distinct cellular masses, and having a fine vascular covering over it. Instead of this excrescence, there often appears a considerable bag descending from the scalp over the back of the trunk, containing a serous fluid, and at times portions of brain, having a communication with the cranium.

DCCCCXXIII.

Morbid State of the Cranial Bones.

A general diseased thickening of the whole cranial bones has at times occurred, so as to press upon the cavity of the brain; and with this thickness they acquire, at the same time, a spongy texture. A partial growth has also been noticed, or an ivory-like needle protruding into the cranial cavity, forming a permanent cause of compression upon the brain. The natural irregularity of the inner surface of the cranial base, consisting in its ridges lengthening and forming sharp spiculi, is a frequent source of irritation of the nervous system.

DCCCCXXIV.

Forms of Injections used for Anatomical Preparations adapted to the different Kinds of Preparations commonly made.

1. In forming coloured injections, it is necessary, in order to their use, that they should be liquified by a degree of heat less than that of the boiling point, that the texture of the vessels to be filled may not be destroyed; and next, that it should remain somewhat solid, or rather ductile, when introduced; and again brought to the ordinary temperature. The only exception to this rule is in the corroded preparations, when the greatest degree of solidity in the injection is required.

2. Anatomical injections are of four kinds; *Coarse, Fine, Minute, and Mercurial.*

Coarse Injections.

The coarse is commonly employed for entire subjects or extremities, or for large vessels, where no minute parts are to be filled. It may be variously coloured; and its ingredients consist of the following proportions:

FORMS.

Red.

Yellow bees wax, 16 ounces;

White resin, 8 ounces;

Turpentine varnish, 6 ounces;

Vermilion, 3 ounces.

The three first ingredients are to be liquified over a slow fire, and the vermilion afterwards added by mixing it first with a little of the liquified composition, and stirring it well with a wooden pestle. The whole of the ingredients being then blended together and heated, the injection will be fit for use.

Yellow.

Yellow bees wax, 16 ounces ;
 White resin, 8 ounces ;
 Turpentine varnish, 6 ounces ;
 King's yellow, $2\frac{1}{2}$ ounces.

White.

Fine bees wax, 16 ounces ;
 White resin, 8 ounces ;
 Turpentine varnish, 6 ounces ;
 Flake-white, $5\frac{1}{2}$ ounces.

Pale Blue.

White bees wax, 16 ounces ;
 White resin, 8 ounces ;
 Turpentine varnish, 6 ounces ;
 Best flake-white, $3\frac{1}{2}$ ounces ;
 Fine blue smalt, $3\frac{1}{2}$ ounces.

Dark Blue.

• White bees wax, 16 ounces ;
 White resin, 8 ounces ;
 Turpentine varnish, 6 ounces ;
 Blue verditer, $10\frac{1}{2}$ ounces.

Black.

Yellow bees wax, 16 ounces ;
 White resin, 8 ounces ;
 Turpentine varnish, 6 ounces ;
 Lamp black, 1 ounce.

Green.

• Yellow bees wax, 16 ounces ;
 White resin, 8 ounces ;
 Turpentine varnish, 6 ounces ;

Chryſtallized verdigrife, $4\frac{1}{2}$ ounces ;

Beſt flake-white, $1\frac{1}{2}$ ounce.

Gamboge, 1 ounce.

Fine Injections.

The ſecond kind of injection, or the fine, is appropriated for filling the ſmaller branches of the principal veſſels, part of which being firſt thrown in, is ſucceeded by the coarſe, to force it on and fill the minute parts. The forms of fine injection are :

FORMS.

Red.

Brown ſpirit varniſh,

White ſpirit varniſh, of each 4 ounces ;

Turpentine varniſh, 1 ounce ;

Vermilion, 1 ounce.

Yellow.

Brown ſpirit varniſh,

White ſpirit varniſh, of each 4 ounces ;

Turpentine varniſh, 1 ounce ;

King's yellow, $1\frac{1}{4}$ ounce.

White.

Brown ſpirit varniſh,

White ſpirit varniſh, of each 4 ounces ;

Turpentine varniſh, 1 ounce ;

Beſt flake-white, 2 ounces.

Light Blue.

Brown ſpirit varniſh,

White ſpirit varniſh, of each 4 ounces ;

Turpentine varniſh, 1 ounce ;

Fine blue ſmalt, $1\frac{1}{2}$ ounce ;

Beſt flake-white, $1\frac{1}{4}$ ounce.

Dark Blue.

Brown spirit varnish,
White spirit varnish, of each 4 ounces;
Turpentine varnish, 1 ounce;
Blue verditer, 4 ounces.

Black.

Brown spirit varnish,
White spirit varnish, of each 4 ounces;
Turpentine varnish, 1 ounce;
Lamp-black, $\frac{1}{2}$ ounce.

When the coarse and fine injections lose part of their fluidity by frequent melting, a little more of the turpentine varnish is to be added to the mass, and the quantity may be judged of by its ductility.

Minute Injections.

The third kind, or minute injections, is adapted solely to the smaller ramifications of the vessels; and the size being the chief part of the receipt, is thus prepared:

Take the finest glue or isinglass, one pound; break the glue into small pieces, and putting them into an earthen pot, pour on them three pints of cold water: when it has stood 24 hours, occasionally stirring it, it is to be placed on a slow fire till dissolved, which generally requires half an hour. When removed, and skimmed from its froth, and passed through a fine cloth of canvas or flannel, it is then fit for the additional ingredients,

FORMS.

Red.

Size, 1 pint;
Vermilion, $3\frac{1}{2}$ ounces;

Yellow.

Size, 1 pint;

King's yellow, $2\frac{1}{2}$ ounces.

White.

Size, 1 pint;

Best flake-white, $3\frac{1}{2}$ ounces.

Blue.

Size, 1 pint;

Fine blue smalt, 6 ounces.

Green.

Size, 1 pint;

Chrystallized verdigrise, 2 ounces;

Best flake-white,

Gamboge, of each eight scruples.

Black.

Size, 1 pint;

Lamp black, 1 ounce;

These injections do not keep unless they are dried.

The fourth kind of injection, or quicksilver, requires no particular preparation, but much nicety and caution in conducting the operation with it in order to be successful.

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